METALLIC MINERALS WASTE MANAGEMENT PERMIT APPLICATION

FOR THE HERCULANEUM FACILITY
SLAG DISPOSAL AREA

The Doe Run Company
Herculaneum Smelter Facility
Herculaneum, Missouri

February 1990

3502

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ENVIRODYNE ENGINEERS, INC.

1908 Innerbelt Business Center Drive
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INTRODUCTION

This is an application for a metallic minerals waste management permit to operate a Waste Management Area (WMA) for the disposal of slag. The slag is generated at the Herculaneum Smelter Facility of The Doe Run Company. The WMA is adjacent to the smelter area. Both the WMA and the smelter are located on part of the contiguous property owned by the Doe Run Company at that facility.

This permit application has been prepared in accordance with the Implementation Guidelines of House Bill No. 321, Sections 5, 6, and 7. In Section 5 of the Implementation Guidelines there are twelve items listed which are to be included in the permit application. This application addresses those twelve items in the order listed in Section 5.

ITEM 1: LEGAL DESCRIPTION OF THE WASTE MANAGEMENT AREA

The Waste Management Area (WMA) is located near Herculaneum, in Jefferson County, Missouri. The U.S. Geological Survey Quadrangle Map (Herculaneum 7.5') shows that the WMA is located in Section 29, T41N, R6E. Figure 1 shows the location of Jefferson County and the approximate location of the WMA. Figure 2 shows the Herculaneum Smelter Facility, the WMA and the property boundaries of The Doe Run Company.

ITEM 2: NAME OF THE OWNER OF THE WMA

Both the Smelter Facility and the WMA are owned and operated by The Doe Run Company.

ITEM 3: ADDRESS AND PHONE NUMBER

The address and telephone number of the general office of The Doe Run Company is:

The Doe Run Company
11885 Lackland Road
St. Louis, Missouri 63146
(314) 991-7100

The address and telephone number of the general office at the Herculaneum Smelter Facility of The Doe Run Company is:

The Doe Run Company
Herculaneum Smelter Facility
881 Main Street
Herculaneum, Missouri 63048
(314) 933-3143

ITEM 4: NAME AND ADDRESS OF THE POINT OF CONTACT

The name and address of the person at the Herculaneum Smelter Facility to whom all correspondence should be addressed is:

Mr. James Lanzafame
The Doe Run Company
Herculaneum Smelter Facility
881 Main Street
Herculaneum, Missouri 63048
(314) 933-3143

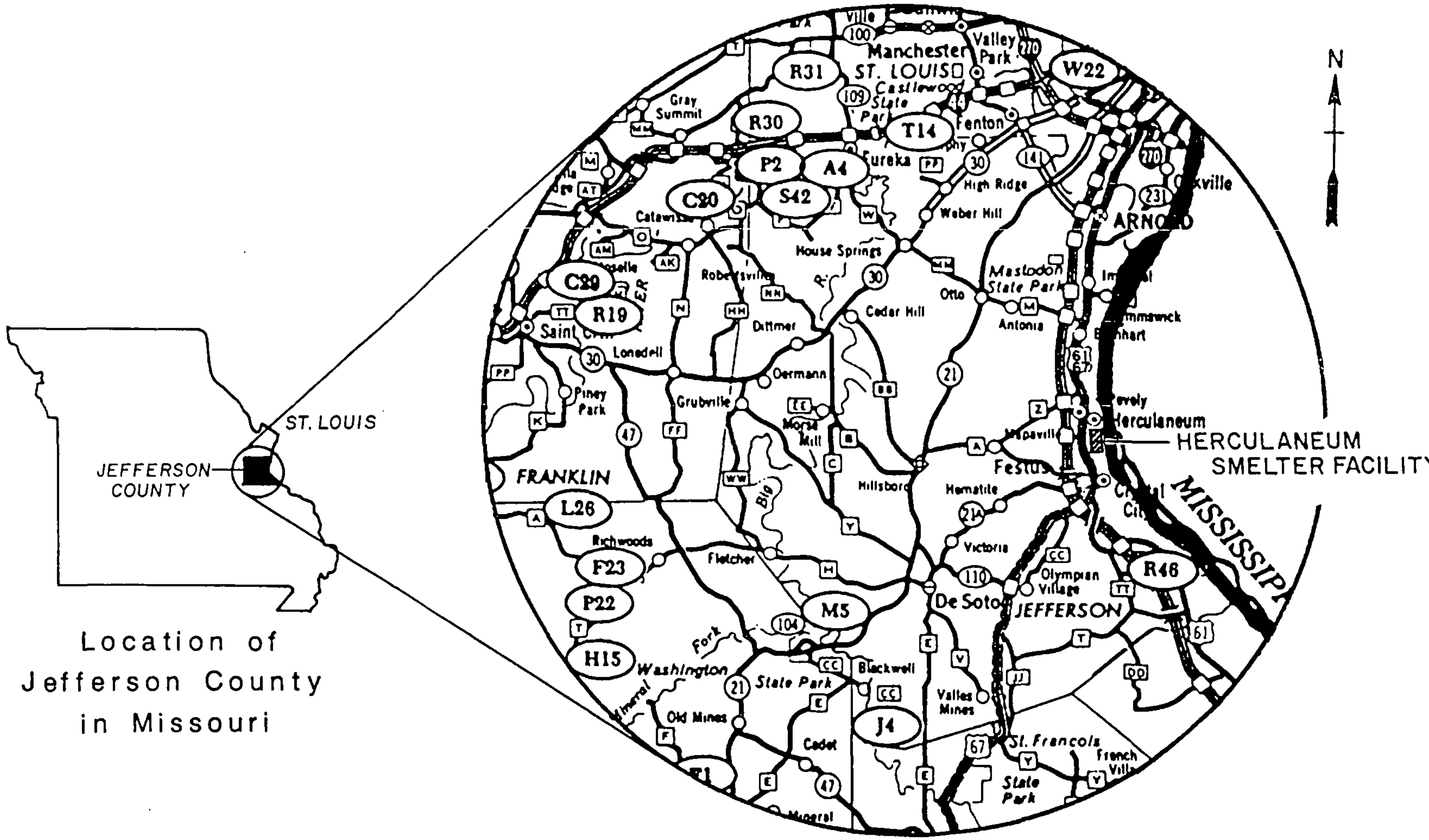

FIGURE 1

VICINITY MAP
The Doe Run Company
Herculaneum Smelter Facility

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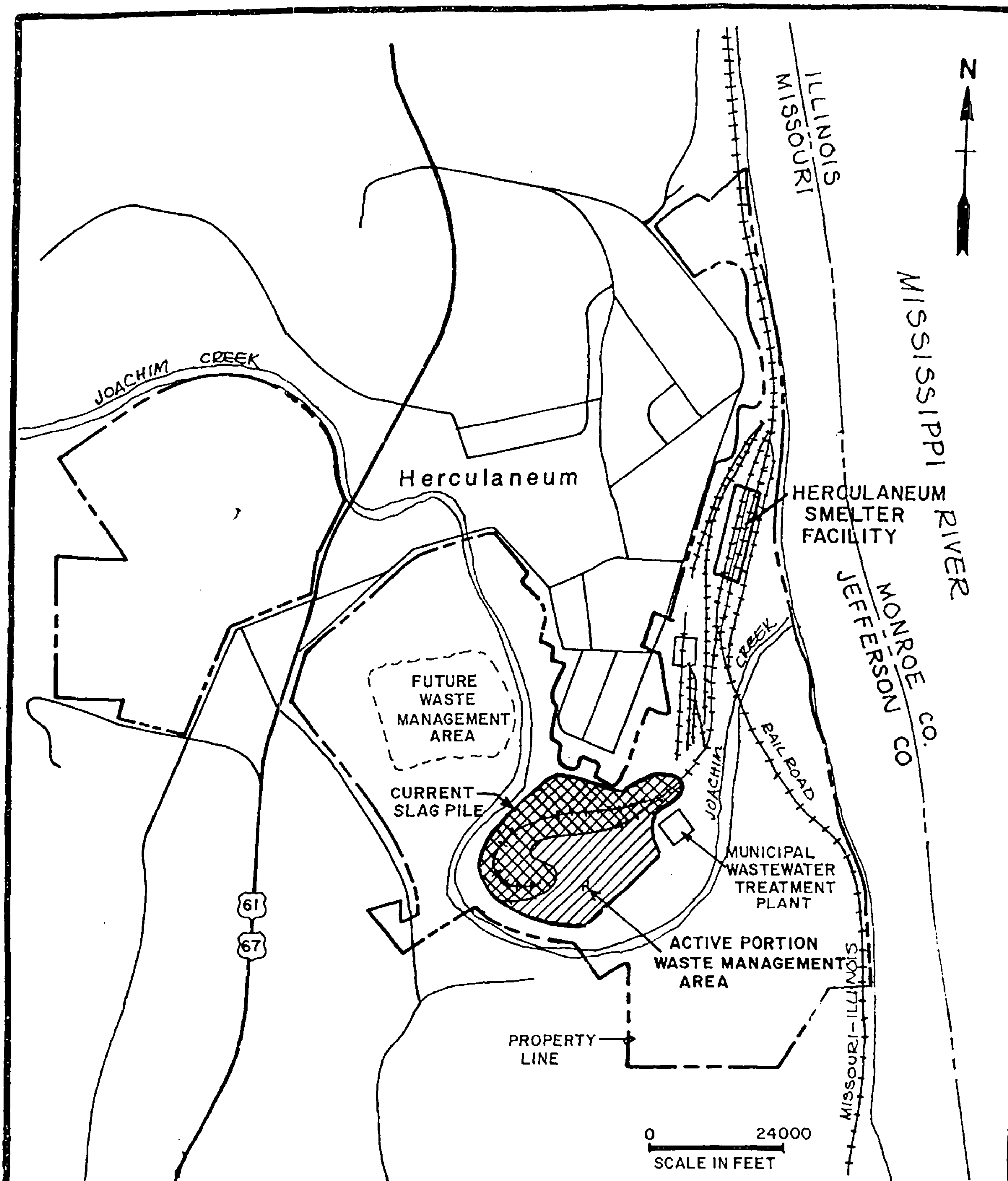

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FIGURE 2

Project Location Map
The DOE RUN COMPANY
Herculaneum Smelter Facility

ITEM 5: RIGHT TO OPERATE STATEMENT

The Doe Run Company is both the fee owner of the surface of the WMA as well as the operator, so no statement of the right to operate is required.

ITEM 6: ESTIMATE OF OPERATING LIFE OF THE WMA

The WMA contains two parts as described in Items 8 and 9. The active portion of the WMA has an estimated remaining life of approximately 20 years. This is based on two assumptions. The first assumption is that the smelter facility will continue to generate slag at the current rate of generation. The second assumption is that the proposed conceptual design will be implemented.

The portion of the WMA planned for future expansion has an estimated life of approximately 20 years. This estimate is also based on two assumptions. The first is that the smelter facility will continue to generate slag at the current rate of generation. The second assumption is that the design of the slag disposal operations in that portion of the site will be very similar to the design proposed for the active portion of the WMA.

ITEM 7: WRITTEN CONSENT TO ALLOW ACCESS

Consent for the Director or his agents to access the site for inspection purposes is contained in the cover letter attached to this document.

ITEM 8: MAP OF THE WMA

Maps of the WMA are included as Sheets 1-4 which show the required information. The following correlates the Item 8 Subsection Numbers with the Sheet Numbers containing the information.

Subsection Number	Sheet Number Containing Required Information
8.a.	Sheets 3 and 4
8.b.	Sheets 3 and 4
8.c.	None required for Smelter Facility
8.d.	Sheets 1 and 2
8.e.	All Sheets
8.f.	Sheet 1 and Groundwater Protection Plan

ITEM 9: CLOSURE PLAN

The details of Item 9 of the application are contained in Section 6 of the Implementation Guidelines. Item 9 will therefore be addressed according to the numbering system of Section 6.

Section 6.1 (1): Containment of Wastes On-Site

Closure of the WMA is intended to retain the slag pile within the WMA and to generally minimize its contact with the environment. Key features of this closure concept include:

(1) grading the surface of the slag pile to achieve positive drainage without allowing slopes so steep that excessive erosion and/or sloughing occurs, direct runon around the WMA and runoff to swales or interceptor ditches within the WMA;

(2) covering the slag pile with soil to minimize infiltration of rainfall, prevent wind and water erosion of the slag pile, and discourage unauthorized removal of slag from the WMA; and

(3) revegetating the cover soil to aid in the control of erosion, promote transpiration of rainfall, improve the WMA appearance, and support the area's final designated use as wildlife habitat.

The dimension and final grades of the slag pile are not precisely defined at this time because the size of the pile is dependent upon the production at the facility prior to closure. However, the projected areal extent and approximate final grades of the WMA at closure are depicted on the attached drawings, Sheets 1 through 4.

Prior to the placement of the soil cover, it will be necessary to grade the slag pile. It is anticipated that soil located within The Doe Run complex will be used for the cover. The cover soil will be placed in several lifts. Each lift will be compacted with appropriate construction equipment. The detailed grading plan for the WMA will be developed to slope the slag pile toward adjacent natural ground at grades in the two to five percent range where possible to achieve good surface drainage while minimizing erosion potential. Steeper slopes may be necessary in some locations within the WMA. In such locations the maximum cover slope will be 3 horizontal to 1 vertical. Depending on the height of the slope, benches may be included to provide access for inspection and maintenance, reduce the possibility of slippage along the soil-slag interface, and to intercept and direct slope runoff to the edge of the WMA. The top of the slag pile will be graded to direct runoff away from the steeper slopes.

Surface water runon will be prevented by constructing a swale excavated into the natural ground along the uphill boundary of the WMA. This swale will be routed around the base of the pile. Runoff from the WMA will be intercepted by swales within the WMA. The swales will be routed to direct the runoff to the base of the covered slag pile.

Erosion from the direct action of Joachim Creek does not currently appear to be a problem. Typically when the level of the creek rises to the elevation of the toe of the current slag pile the stage of the Mississippi River is also at that elevation, and the velocity of the water is extremely low (backwater effect). This is demonstrated by the fact that there has been very little slag spread by water in the area between the toe of the slag pile and the creek. Some slag has been spread by truck traffic and foot traffic, but away from the roadways there appears to be essentially no slag on the ground surface. It therefore appears that erosion of the wastes from the direct action of Joachim Creek will not be a problem for the completed fill.

The slag pile area soil cover and the disturbed areas within the WMA will be revegetated. An appropriate mix of grasses and/or legumes will be selected to provide vegetation which will limit erosion and provide wildlife habitat.

Section 6.1 (2): Continued Integrity of the Waste Management Structures

No qualifying structures are present or planned within the WMA or immediate vicinity.

Section 6.1 (3): Proposed Final Designated Use

The proposed final designated use of the WMA will be as a wildlife area. It will be developed for this use through planting with a mixture of shallow-rooted vegetation. The areas adjacent to the site are heavily dissected hills and floodplains with readily available water and a wide variety of associated wildlife. The open space, edge, and increased diversity of vegetation which will result from development of the WMA will increase the habitat potential of the area.

Section 6.2: Final Designated Use

See Section 6.1 (3) above.

Section 6.3 (1): Surface Water Management

There currently is no point source discharge from the WMA, and so there is no current NPDES Permit specifically for the WMA. There is an NPDES Permit for the Herculaneum Smelter Facility.

Section 6.3 (2): Groundwater Protection Plan

Introduction

The WMA is located in the bottomland of Joachim Creek, approximately 1,000 feet from its confluence with the Mississippi River. An aerial photograph of the WMA and the surrounding area is included as Sheet 1. The WMA consists of two subareas separated by Joachim Creek. The portion of the WMA which is currently active is referred to as the eastern portion and the area set aside for future expansion is referred to as the northwestern portion. The northern boundary of the eastern portion of the WMA coincides with the southern boundary of the City of Herculaneum. The Herculaneum Sewer District Wastewater Treatment Plant is located directly to the east of the eastern portion of the WMA, and the remainder of the eastern portion of the WMA is surrounded by Joachim Creek. The top of the current slag pile is approximately 30-40 feet above the surrounding Joachim Creek bottomland. It currently covers approximately 22 acres as seen in Sheets 2 and 3.

The portion of the WMA set aside for future expansion is located northwest of the currently active portion and is shown in Figure 2 and Sheets 1 and 4. This northwestern portion encompasses approximately 40 acres and is expected to have a 20-25 year capacity (1,000,000 cubic yards). This portion of the WMA will be filled after the currently active portion has reached its capacity.

Slag Characteristics

See Item 12 for a discussion of the characteristics (physical and chemical) of the slag.

General Approach to Groundwater Protection

See Item 12 for a discussion of the general approach to protection of the groundwater within and downgradient from the WMA.

Background Data

Geology and Soils - (The following information concerning the bedrock geology is based on a summary report submitted to EEI by a representative from the Missouri Department of Natural Resources Geologic Investigation Section.) The surface and near-surface bedrock in the WMA and vicinity consists of three formations (oldest to youngest)--the Everton Group, the St. Peter Sandstone, and the Joachim Dolomite (see Figure 3). The formations are gently dipping to the north at approximately 75-100 feet per mile. Roughly one-half mile to the north of the WMA is a block fault which cuts through the uppermost bedrock units. The fault trends roughly northwest-southeast, with the upthrown side to the southwest (see Figure 3). Throw on this fault is about 100-125 feet.

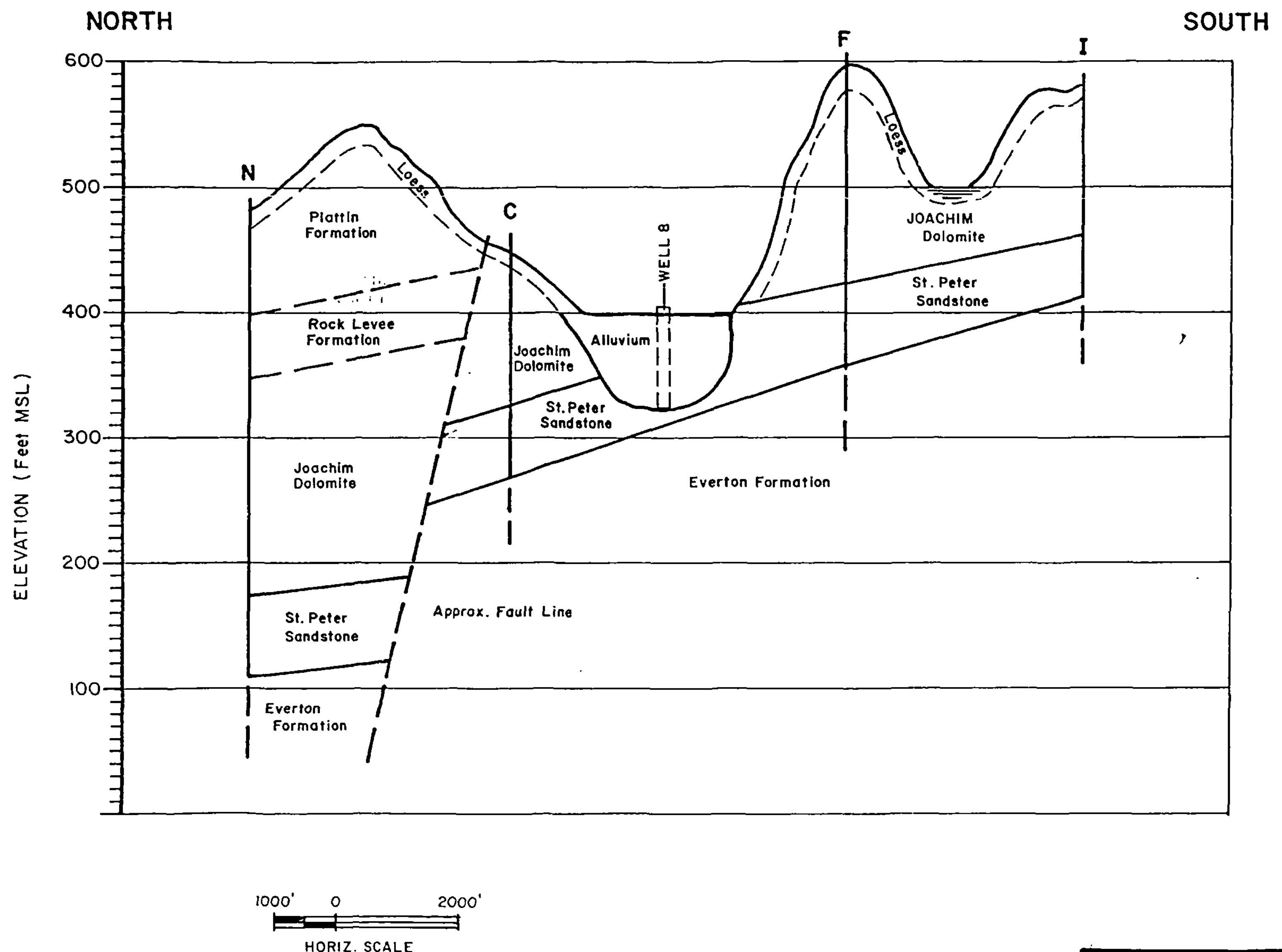
Figures 4 and 5 present geologic cross sections through the WMA. Figure 6 presents the legend for Figures 4 and 5. Figure 7 shows the locations of the cross section lines. The cross sections are based on logs of the borings made during the drilling of the groundwater monitoring wells. As shown in this cross section the thickest part of the Joachim Creek alluvium is approximately 70 feet thick. The alluvium consists primarily of silty clays and clayey silts, with a few strata containing a significant percentage of sand. Tables 1 and 2 present a summary of the physical testing performed on samples of the alluvium collected during drilling.

Well Installation History - As stated above, groundwater in the WMA has been monitored since 1980. The monitoring well network consisted of 14 wells installed during two phases (see Sheet 1 for locations). Wells numbered 1 through 7 were installed in April, 1980 by Raymond International Builders, Inc. The second group of wells (8-14) was installed by Monteagle, Inc., in 1984. The necessity for and placement of the second group of wells was based on recommendations made by Envirodyne Engineers, Inc. (EEI) in July, 1983. Well Number 6 was sealed and grouted in 1987 due to the expansion of the slag pile.

Well Construction - Well 8, with a total depth of 94 feet below grade, is a much deeper well than the rest. It is set in the St. Peter Sandstone (see Figures 3 through 7 for geological cross sections). Well 13 appears to have been drilled through the loess and to be set in alluvium. It is 40 feet deep.

Wells 12 and 14 are both set slightly deeper than the adjacent Wells 5 and 11. Well 5 was installed before that location was covered with slag. As slag was deposited additional PVC casing and steel protector pipe were added in an attempt to continue to use this well for monitoring groundwater beneath the slag. At some point in time the PVC casing was damaged (bent) to the point that the well is unsampleable. Well 11 was installed after the slag pile had reached its current height in an attempt to determine if a groundwater mound existed within the slag itself. The screen for this well is set within the slag. It is therefore not used for groundwater quality monitoring purposes.

The tops of the screens in Wells 12 and 14 were set below the slag/soil interface. Both of these wells were installed by drilling through the slag pile. Well 11 was drilled first. The hole was advanced using hollow stem augers for the full length of the hole. Split spoon samples were collected at regular intervals during drilling. The well was set from inside the hollow stem of the augers. The augers were backed out as the sand pack and grout were placed. However, because of the granular nature of the slag, it was believed by The Doe Run Company that there was a possibility that some slag may have been



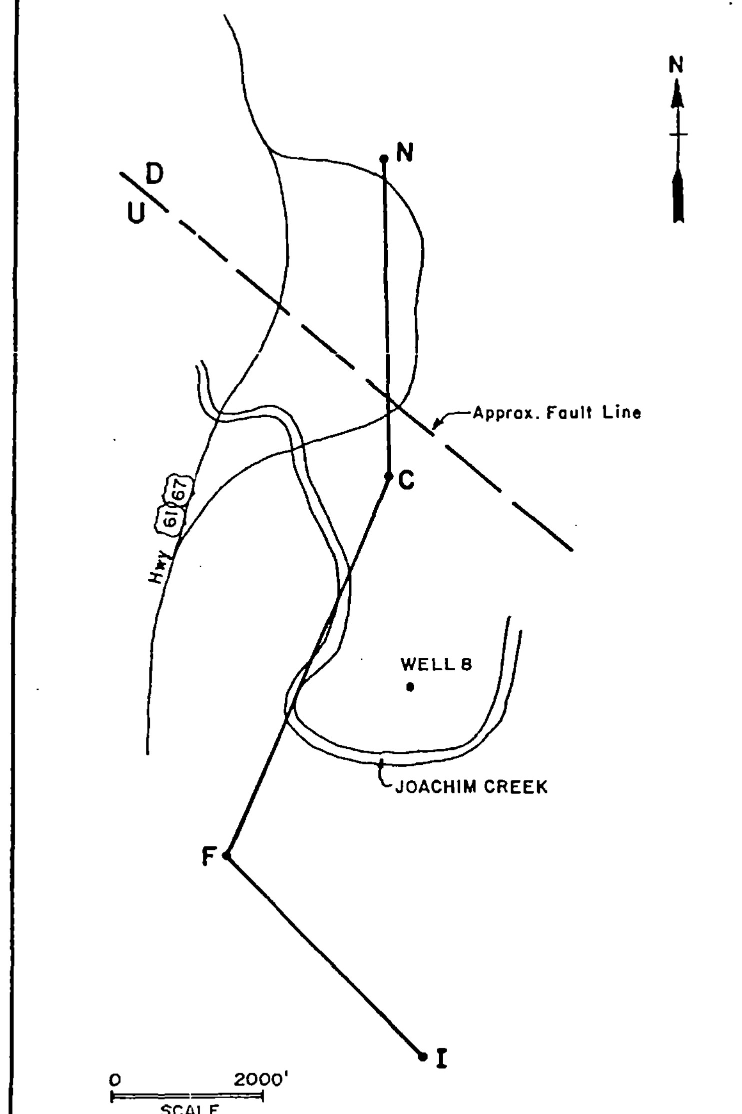


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FIGURE 3

Bedrock Geological Cross-Section

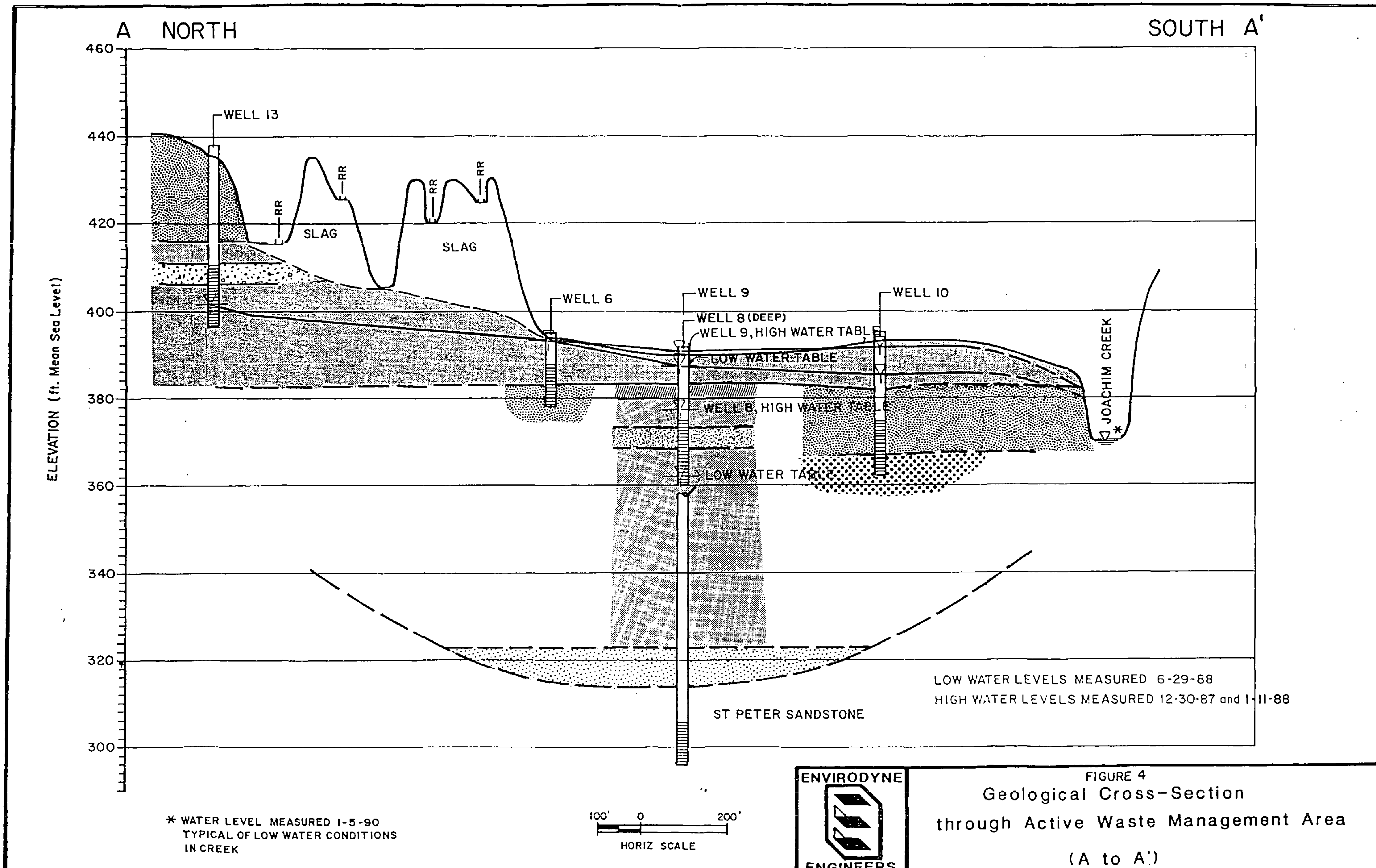

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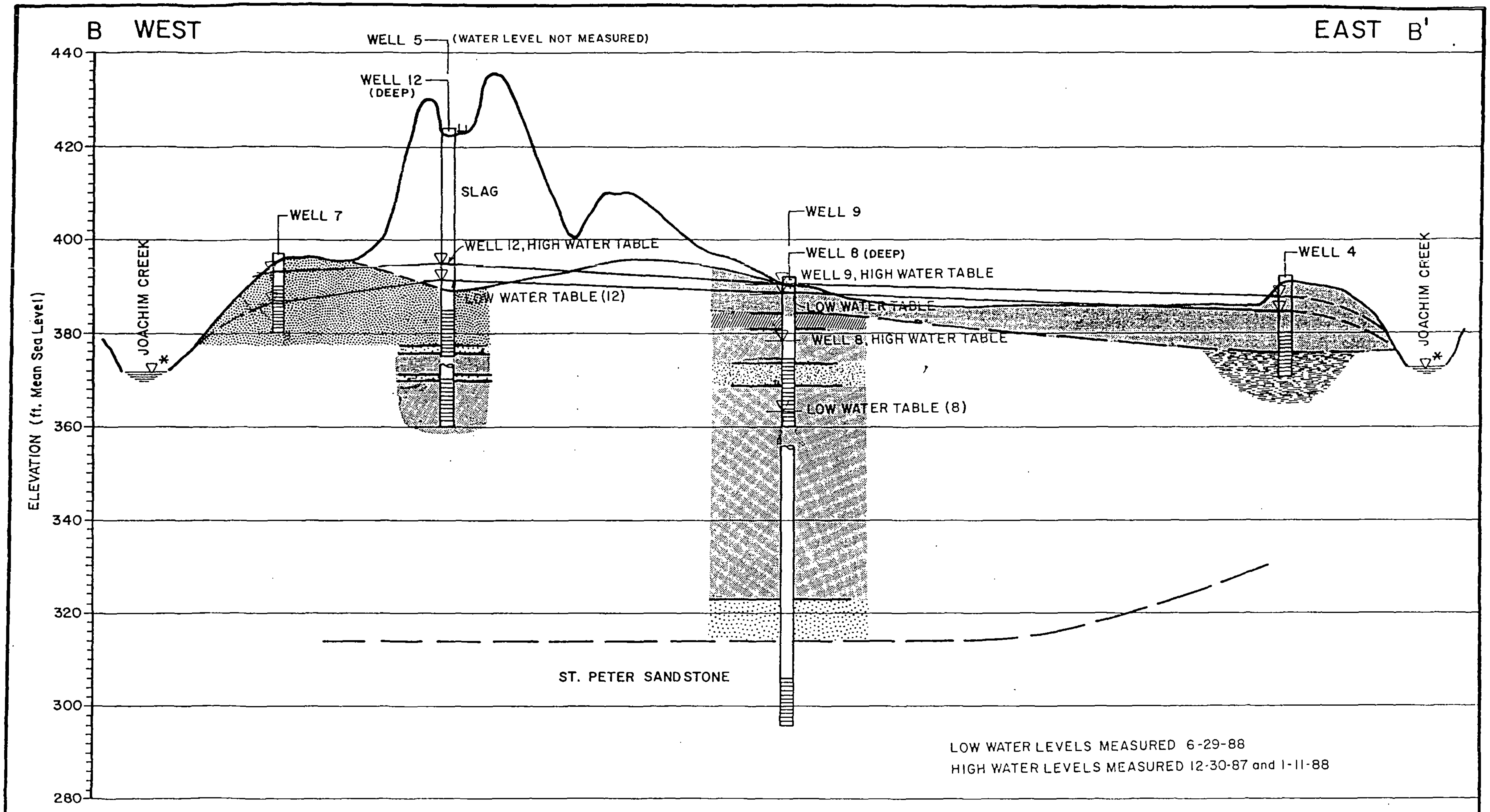
FIGURE 4
Geological Cross-Section through Active Waste Management Area (A to A')



* WATER LEVEL MEASURED 1-5-90
TYPICAL OF LOW WATER CONDITIONS
IN CREEK

100' 0 200'
HORIZ SCALE

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FIGURE 5
Geological Cross-Section
through Active Waste Management Area
(B to B')

LEGEND

- CLAY
- SANDY CLAY
- SILTY SAND
- SANDY CLAYEY SILT
- SILTY CLAY
- SANDY SILTY CLAY
- SILTY CLAYEY SAND
- CLAYEY SAND

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FIGURE 6

Geological Cross-Section Legend for Figures 4 & 5

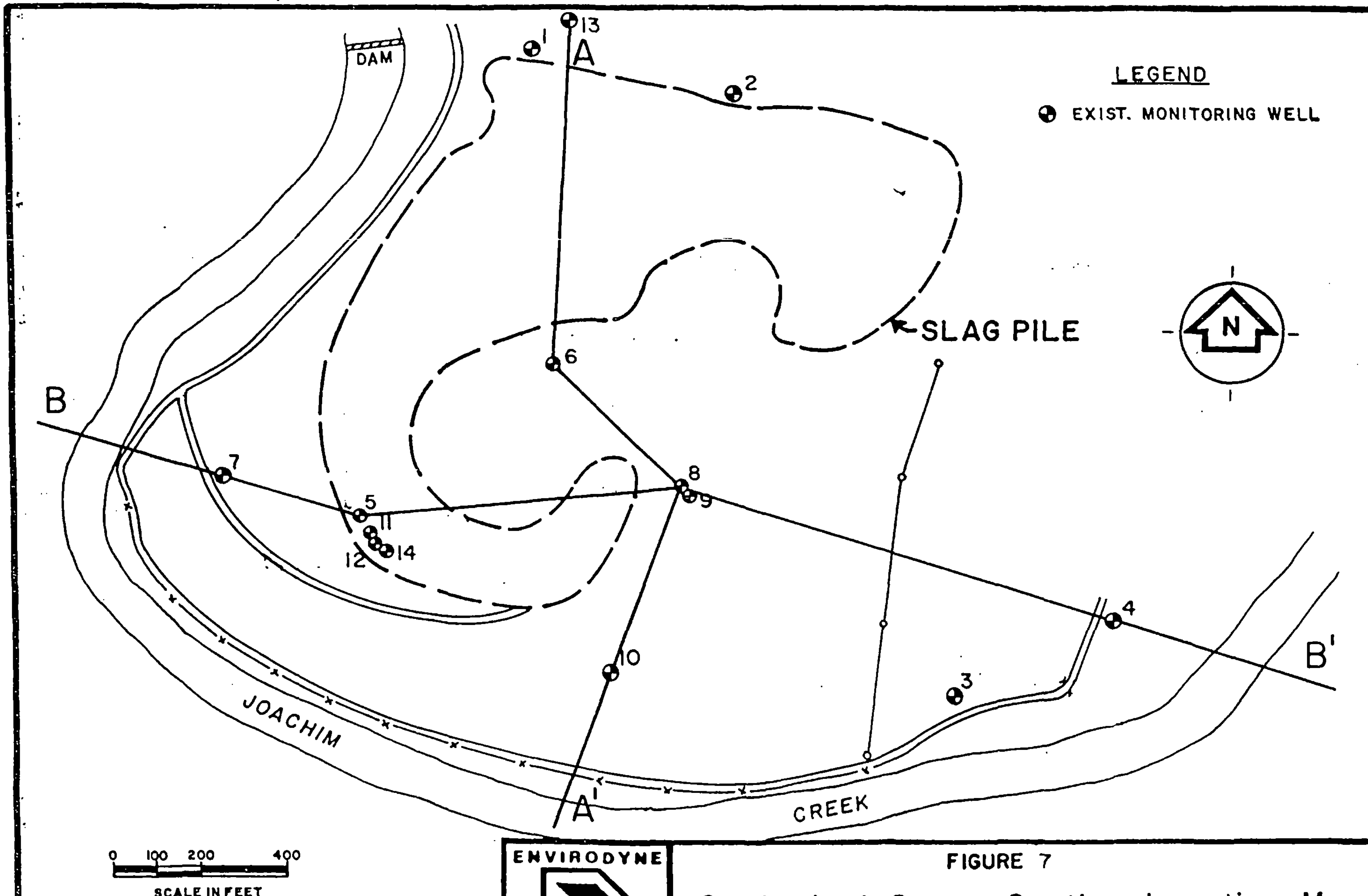

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FIGURE 7

Geological Cross-Section Location Map

Active Waste Management Area

TABLE 1

Summary of Physical Testing
Wells 1 through 7

Boring No.	Sample No.	Lab No.	Depth/Interval (feet)	Cation Exchange Capacity (meq/100 gm)	Textural Classification: Sand (%)	Silt (%)	Clay (%)	USDA Textural Classification
1	1	27208	0-5	0.517	3	67	30	Silty clay loam
1	2	27211	5-10	0.852	20	55	25	Silt loam
1	3	27212	10-15	0.894	20	70	10	Silt loam
1	4	27213	15-20	0.465	15	60	25	Silt loam
1	5	27214	20-25	1.268	15	60	25	Silt loam
2	1	27215	0-5	0.915	5	60	35	Silty clay loam
2	2	27216	5-10	0.794	7	53	40	Silty clay
2	3	27217	10-15	1.300	10	50	40	Silty clay
2	4	27218	15-20	0.417	70	25	5	Sandy loam
3	1	27219	0-5	2.171	10	50	45	Silty clay
3	2	27220	5-10	2.287	5	60	35	Silty clay loam
3	3	27221	10-15	1.776	3	52	45	Silty clay
3	4	27222	15-20	1.581	5	65	30	Silty clay loam
4	1	27223	0-5	1.774	7	48	45	Silty clay
4	2	27224	5-10	2.270	5	45	50	Silty clay
4	3	27225	10-15	2.624	3	57	40	Silty clay
4	4	27226	15-20	2.191	5	35	60	Clay
5	1	27227	0-5	1.388	10	60	30	Silty clay loam
5	2	27228	5-10	1.461	5	60	35	Silty clay loam
5	3	27229	10-15	1.244	2	68	30	Silty clay loam
6	1	27230	0-5	2.391	3	52	45	Silty clay
6	2	27231	5-10	1.447	5	55	40	Silty clay
6	3	27232	10-15	1.146	10	60	30	Silty clay loam
7	1	27233	0-5	1.653	10	55	35	Silty clay loam
7	2	27234	5-10	2.448	10	55	35	Silty clay loam
7	3	27235	10-15	1.251	5	60	35	Silty clay loam

TABLE 2
SUMMARY OF PHYSICAL TESTING
WELLS 8, 10, 11, 12 AND 13

Boring	Sample	Depth (ft)	Liquid Limit	Plastic Limit	% Finer #200	Description
8	1	3.5-5.0	61	14	-	Gr-Br CLAY w/Silt Tr Sa, CH
8	2 (Top)	8.5-10.0	31	11	52.8	Gr-Br Sandy CLAY, CL
8	2 (Bottom)	8.5-10.0	73	22	86.0	Gr-Br CLAY w/Silt Tr Sa, CH
8	3	13.5-15.0	77	24	-	Gr-Br CLAY w/Silt Lenses, CH
8	4	18.5-20.0	37	12	49.8	Gray Clayey SAND w/Silt, SC
8	5	23.5-25.0	50	19	94.9	Dk Gr CLAY w/Silt, CH
8	6	28.5-30.0	51	22	-	Dk Gr CLAY w/Silt, CH
8	7	33.5-35.0	68	22	98.6	Dk Gr CLAY w/Silt, CH
8	8	38.5-40.0	51	22	-	Gr-Br CLAY w/Silt, CH
8	9	43.5-45.0	51	20	-	Gr-Br CLAY w/Silt, CH
8	10	48.5-50.0	50	20	-	Gray CLAY w/Silt, CH
8	11	53.5-55.0	72	26	-	Gray CLAY w/Silt, CH
8	12	58.5-60.0	83	24	-	Dk Gr CLAY w/Silt, CH
8	13	63.5-65.0	74	26	-	Dk Gr CLAY w/Silt Tr Sa, CH
8	14	68.5-70.0	-	-	21.6	Gr-Br Cl GRAVEL w/Sa, GC
8	15	73.5-75.0	-	-	31.1	Br Clayey Fine SAND, SC
10	1	3.5-5.0	-	-	-	Br-Gr Silty CLAY, CL
10	2	8.5-10.0	41	16	-	Br-Gr Silty CLAY, CL
10	3	13.5-15.0	-	-	-	Br-Gr Si CLAY w/Sa, CL
10	4	18.5-20.0	62	21	-	Gray CLAY w/Si, Sa, CH
10	5	23.5-25.0	-	-	-	Gray Sa CLAY w/Si, CL
10	6	30.0-31.5	32	28	-	Gray Clayey SILT w/Sa, ML
11	1	35.0-36.5	46	17	-	Gr-Br Si CLAY Tr Sa, CL
11	2	40.0-41.5	40	15	67.4	Gr-Br Si CLAY w/Sa, CL
12	1 (Top)	45.0-46.5	-	-	41.2	Br Clayey Fine SAND, SC
12	1 (Bottom)	45.0-46.5	-	-	-	Gr-Br Silty CLAY Tr Sa, CL
12	2 (Top)	50.0-51.5	-	-	-	Gr CLAY w/Silt, Gravel, CH
12	2 (Bottom)	50.0-51.5	-	-	-	Br Clayey SAND, SC
12	3	55.0-56.5	-	-	-	Gray CLAY w/Silt, CH
12	4	60.0-61.5	81	27	-	Gray CLAY w/Silt, CH
12	5	65.0-66.5	-	-	-	Gray CLAY w/Silt, CH
13	1	8.5-10.0	-	-	-	Br Silty CLAY w/Sa, CL
13	2	13.5-15.0	-	-	-	Br Clayey SILT w/Sa, ML
13	3	18.5-20.0	-	-	84.4*	Br Clayey SILT w/Sa, ML
13	4	23.5-25.0	56	24	93.0*	Br-Gr CLAY w/Silt, CH
13	5	28.5-30.0	-	-	-	Br Silty Fine SAND, SM
13	6	35.0-36.5	-	-	-	Gr-Br CLAY w/Silt, CH
13	7	40.0-41.5	78	25	95.4*	Dk Gr CLAY w/Si Tr Sa, CH

* Insufficient Amount of Sample for Required Sieve Analysis.

dragged down the hole during drilling and/or well installation procedures. Well 14 was therefore installed using a different technique.

The hole for Well 14 was advanced to the slag/soil interface using hollow stem augers. A permanent steel casing was then placed inside the hollow stem of the augers and grouted into place. The grout inside the casing was then drilled out and the hole advanced to depth using standard rotary drilling techniques. The PVC screen, casing, sandpack and grout were then placed inside the steel casing. It is believed that this technique minimized the potential for slag to fall or be dragged down into the screened interval of the hole. The rest of the monitoring wells are set in the silty/clayey alluvium of Joachim Creek as close to the water table as possible while still achieving a good grout seal above the well screens. Typical top of well screen elevations for these wells range from 375 to 396 feet above sea level. Table 3 summarizes the construction details of these groundwater monitoring wells.

There are numerous groundwater production wells (residential, municipal and industrial) within a 1-mile radius of the WMA. The locations of the wells identified to date are presented in Sheet 1. All of these wells draw their water from the bedrock formations. None of the wells draw water from the silty/clayey Joachim Creek alluvium. Table 4 summarizes the information available for the construction of these wells.

Current Monitoring Program - Not all of the existing groundwater monitoring wells are currently being sampled and analyzed. Wells 1, 2, 5, and 11 are not part of the present monitoring program. It is believed that the remaining wells provide adequate information concerning the quality of the groundwater within the WMA.

These remaining wells (numbers 3, 4, 7, 8, 9, 10, 12, 13, and 14) are sampled and analyzed on a quarterly basis for dissolved lead, nickel, and zinc. Electrical conductivity (E.C.) and pH values were monitored quarterly as indicator parameters. Samples from these wells are also analyzed on an annual basis for all of the metals listed in Table 1 of 40 CFR 264.94. These include arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. Lead, nickel, and zinc were the only metals chosen for quarterly monitoring because they were the only metals which leached out of the slag when the slag was subjected to the EP Toxicity test. The other metals have been monitored only as a precautionary measure, and so have been monitored on a less frequent basis.

A summary of the laboratory data for the past two years is presented in Tables 5 through 12. As can been seen from the data, the slag has had very little impact on the groundwater quality. A statistical analysis of the data included in Tables 5 through 12 has shown that zinc concentrations in well number 14 and electrical conductivity measurements in well numbers 4, 7, 9, 10, and 14 to be significantly higher than background well concentrations (well number 13), though the zinc concentration is still well below the

TABLE 3

SUMMARY OF GROUNDWATER MONITORING WELL CONSTRUCTION WELLS 1 THROUGH 14

Well Number	Total Length of Well BGL	Total Length Well Screen	Top of Well Screen (MSL)
1	30'	5'	388.30'
2	25'	5'	396.86'
3	20'	7.5'	380.05'
4	20'	7.5'	379.83'
5	-	-	-
6	15'	10'	387.62'
7	15'	10'	389.83'
8	94'	10'	305.99'
9	29.9'	15'	374.89'
10	30.3'	15'	377.35'
11	41.5'	10'	390.43'
12	61.6'	10'	369.75'
13	40'	15'	410.30'
14	67'	15'	369.66'

DRM006/1

TABLE 4

SUMMARY OF PRODUCTION WELL CONSTRUCTION WELLS A THROUGH O

Well	Ground Surface Elevation (Feet above MSL)	Uppermost Bedrock Formation	Top and Bottom Elevation of St. Peter Sandstone (Feet above MSL)	St. Peter Sandstone Thickness (ft)
A	445	Joachim	395-325	70
B	442	St. Peter	392-342	50
C	450	St. Peter (?)	325-270	55
D	510	Joachim	415-365	50
E	565	Joachim	465 (top)	-
F	598	Joachim	423-358	65
G	565	Joachim	410 (top)	-
H	610	Joachim (?)	440 (top)	-
I	582	Joachim	462-412	50
J	608	Joachim	438-378	60
K	598	Plattin	423-358	65
L	398	Plattin	253 (top)	-
M	403	?	223 (top)	-
N	480	Plattin	175-110	65
O	552	Plattin	202-162	40

DRM006/1

TABLE 5

ANALYTICAL RESULTS
DOE RUN - HERCULANEUM
COLLECTION DATE: 9-3-87

Well	Depth	Elevation	pH	EC	T	Ag	As	Ba	Cd	Cr	Hg	Ni	Pb	Se	Zn
	Ft below top of casing	ft msl		umho/cm	°C	mg/l	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	ug/l	mg/l
3	9.17	383.38	7.4	1100	15	<.02	<3.1	.092	<.005	<.01	<0.2	<0.02	<.02	<2.1	<0.02
4	7.63	384.70	7.4	1200	15	<.02	<3.1	.130	<.005	<.01	<0.2	<0.02	<.02	<2.1	0.03
7	8.58	388.24	8.0	1200	20	<.02	<3.1	.121	<.005	<.01	<0.2	<0.02	<.02	<2.1	0.04
8	34.08	358.37	7.2	980	15	<.02	<3.1	.173	<.005	<.01	<0.2	<0.02	<.02	<2.1	<0.02
9	3.92	388.97	7.6	1800	17	<.02	<3.1	.142	<.005	<.01	<0.2	<0.02	<.02	<2.1	<0.02
10	8.04	387.11	7.6	1700	17	<.02	<3.1	<.05	<.005	<.01	<0.2	<0.02	<.02	<2.1	<0.02
11	29.42	395.01				Well not routinely sampled									
12	30.92	392.93	8.6	1300	19	<.02	11.09	.184	<.005	<.01	<0.2	<0.02	<.02	<2.1	<0.02
13	35.67	402.13	7.5	1000	15	<.02	<3.1	.087	<.005	<.01	<0.2	<0.02	<.02	<2.1	<0.02
14	30.92	393.24	7.8	1800	19	<.02	<3.1	.104	<.005	<.01	<0.2	<0.02	<.02	<2.1	0.06

River Stage at Dock: 381.08 ft msl at 9:30 AM September 3, 1987

TABLE 6

ANALYTICAL RESULTS
DOE RUN - HERCULANEUM
COLLECTION DATES 12/30/87 (1) and 1/11/88 (2)

	Depth to Water	Elevation of Water Table	pH	Electrical Conductivity	Temperature	Nickel	Lead	Zinc
Well No.	Ft. Below Top of Casing	Ft.-MSL		umhos/cm	°C	mg/l	mg/l	mg/l
3 (2)	8.38	383.72	6.4	620	12	0.003	<0.005	0.016
4 (2)	6.50	385.83	6.7	890	12	0.003	<0.005	0.027
7 (1)	2.23	394.59	7.0	1010	13	0.003	<0.005	0.027
8 (1)	14.63	377.82	7.0	690	12	<0.002	<0.005	0.013
9 (1)	0.94	391.95	6.5	1420	12	<0.002	<0.005	0.016
10 (1)	2.90	392.25	6.8	1290	13	0.003	<0.005	0.008
12 (1)	28.75	395.10	7.4	920	14	<0.002	<0.005	<0.002
13 (1)	34.96	402.84	6.9	750	13	0.003	<0.005	0.011
14 (1)	28.83	395.33	6.8	2050	16	<0.002	<0.005	0.056

Mississippi River Stage: 388.88 ft.-MSL, measured 12/30/87 at 12:45 PM.

TABLE 7
ANALYTICAL RESULTS
DOE RUN - HERCULANEUM
COLLECTION DATES 3/30/88 (1)

Well No.	Depth to Water Ft. Below Top of Casing	Elevation of Water Table Ft.-MSL	pH	Electrical Conductivity umhos/cm	Temperature °C	Nickel mg/l	Lead mg/l	Zinc mg/l
3	4.58	387.97	6.7	824	11.6	0.024	0.012	0.024
4	6.85	385.48	7.0	1264	12.0	0.009	0.017	0.066
7	1.50	395.32	7.0	963	11.3	0.014	0.020	0.093
8	22.81	369.64	7.6	785	13.9	0.011	0.015	0.019
9	11.02	381.87	6.3	1743	14.1	0.008	0.016	0.014
10	3.43	391.72	6.9	1621	12.8	0.009	0.010	0.006
12	28.85	395.02	7.1	1164	16.9	0.008	0.014	0.006
13	33.83	403.97	6.8	1036	12.9	0.009	0.009	0.012
14	29.00	395.16	6.5	2600	17.8	0.018	0.015	0.054

Mississippi River Stage: 381.1 ft.-MSL, measured 3/30/88 at 9:45 AM.

TABLE 8

ANALYTICAL RESULTS
DOE RUN - HERCULANEUM
COLLECTION DATES 6/29/88

Well No.	Depth to Water Ft. Below Top of Casing	Elevation of Water Table Ft.-MSL	pH	Electrical Conductivity umhos/cm	Temperature °C	Nickel mg/l	Lead mg/l	Zinc mg/l
3	12.7	379.85	6.55	1005	12.6	0.006	0.006	0.033
4	9.0	383.33	6.90	1597	13.1	0.008	<0.006	0.037
7	9.75	387.07	6.90	1580	13.5	0.005	0.010	0.034
8	29.5	362.95	7.15	795	14.7	0.006	<0.006	0.020
9	4.5	388.39	6.50	1770	15.2	<0.004	0.015	0.016
10	9.0	386.15	6.80	625	13.0	0.005	<0.006	0.013
12	31.9	391.95	7.05	1257	18.0	<0.004	<0.006	0.013
13	33.9	403.90	6.80	1050	16.1	<0.004	<0.006	0.019
14	32.3	391.86	6.55	2780	18.9	<0.004	0.011	0.088

Mississippi River Stage: 364.1 ft.-MSL, measured 6/29/88 at 8:30 AM.

TABLE 9

ANALYTICAL RESULTS

DOE RUN - HERCULANEUM

COLLECTION DATE: September 29, 1988

Well	Depth	Elevation	pH	EC	T	Ag	As	Ba	Cd	Cr	Hg	Ni	Pb	Se	Zn
	Ft. Below top of casing	Ft. msl		umho/ cm	*C	mg/l	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	ug/l	mg/l
3	15.0	377.55	6.5	817	14.2	<0.003	<3.1	0.131	0.002	<0.004	<0.2	0.013	<0.005	<2.1	0.030
4	10.5	381.83	6.7	2160	14.7	<0.003	<3.1	0.184	0.003	<0.004	<0.2	0.016	<0.003	3.3	0.045
7	9.8	387.02	6.9	1774	16.0	<0.003	<3.1	0.105	0.002	<0.004	<0.2	0.013	<0.003	2.5	0.043
8	31.3	361.15	7.3	686	16.2	<0.003	<3.1	0.107	<0.002	<0.004	<0.2	0.008	<0.003	<2.1	0.015
9	4.7	388.18	6.6	1668	15.5	<0.003	6.0	0.131	0.002	<0.004	<0.2	0.010	<0.003	<2.1	0.041
10	9.5	385.65	6.7	1649	14.3	<0.003	<3.1	0.038	<0.002	<0.004	<0.2	0.008	<0.003	<2.1	0.019
12	31.8	392.05	7.0	1153	18.9	<0.003	21.0	0.176	0.002	<0.004	<0.2	0.009	<0.003	<2.1	0.017
13	36.0	401.80	6.9	929	14.6	<0.003	<3.1	0.089	0.002	0.005	<0.2	0.010	<0.003	<2.1	0.024
14	31.9	392.26	6.6	2670	19.9	<0.003	<3.1	0.052	0.003	<0.004	<0.2	0.011	<0.003	<2.1	0.049

River Stage at Dock: 367.04 ft. msl at 8:15 AM September 29, 1988.

TABLE 10

ANALYTICAL RESULTS
DOE RUN - HERCULANEUM
COLLECTION DATE - DECEMBER 29, 1988

Well No.	Depth to Water Ft. Below Top of Casing	Elevation of Water Table Ft.-MSL	pH	Electrical Conductivity umhos/cm	Temperature °C	Nickel mg/l	Lead mg/l	Zinc mg/l
3	9.67	382.88	6.7	841	13.1	0.008	<0.006	0.039
4	8.65	383.33	6.4	2620	12.5	0.017	0.010	0.065
7	3.00	393.82	6.8	1345	12.2	0.008	<0.006	0.068
8	27.83	364.62	7.1	638	11.7	0.008	0.008	0.035
9	1.08	391.81	6.5	1773	11.0	0.007	<0.006	0.048
10	3.92	391.23	6.6	1650	12.0	0.010	0.007	0.035
12	29.04	394.81	7.2	1228	15.4	0.005	0.007	0.034
13	35.33	402.47	6.7	975	10.9	0.008	<0.006	0.045
14	29.08	395.08	6.3	2780	14.3	0.009	0.010	0.048

Mississippi River Stage: 379.08 ft.-MSL, measured 8:00 a.m. on December 29, 1988

/002M

TABLE 11
ANALYTICAL RESULTS
DOE RUN - HERCULANEUM
COLLECTION DATE - March 27, 1989

Well No.	Depth to Water Ft. Below Top of Casing	Elevation of Water Table Ft.-MSL	pH	Electrical Conductivity umhos/cm	Temperature °C	Nickel mg/l	Lead mg/l	Zinc mg/l
3	7.88	384.67	6.4	829	12.9	<0.015	<0.003	0.021
4	6.25	386.08	6.6	2470	12.6	0.018	0.010	0.053
7	2.75	394.07	6.8	1464	12.4	<0.015	0.006	0.024
8	27.29	365.16	7.3	845	15.5	<0.015	<0.003	0.016
9	1.00	391.89	6.7	1750	14.9	<0.015	0.006	0.017
10	4.23	390.92	6.9	1616	12.9	<0.015	0.009	0.045
12	29.06	394.79	7.0	1236	17.9	<0.015	0.004	0.037
13	34.81	402.99	6.9	997	14.1	<0.015	0.004	0.032
14	29.25	394.91	6.9	2670	18.0	0.016	0.017	0.099

Mississippi River Stage: 372.34 ft.-MSL, measured March 27, 1989 at 9 AM.

/002M

TABLE 12

ANALYTICAL RESULTS
DOE RUN - HERCULANEUM
COLLECTION DATES 6/27/89

Well No.	Depth to Water Ft. Below Top of Casing	Elevation of Water Table Ft.-MSL	pH	Electrical Conductivity umhos/cm	Temperature °C	Nickel mg/l	Lead mg/l	Zinc mg/l
3	9.83	382.72	6.70	705	12.9	<0.015	0.005	<0.016
4	6.96	385.37	6.85	2030	12.7	0.016	0.010	0.032
7	7.33	389.49	7.00	1350	14.0	<0.015	0.006	<0.016
8	28.81	363.64	7.30	620	16.0	<0.015	0.006	<0.016
9	1.46	391.43	6.75	1475	15.0	<0.015	0.005	<0.016
10	6.49	388.66	6.95	1250	12.1	<0.015	0.005	<0.016
12	30.71	393.14	7.30	1150	18.9	<0.015	0.003	0.017
13	34.83	402.97	7.00	900	14.9	<0.015	<0.001	<0.016
14	30.83	393.33	6.60	2390	18.0	<0.015	0.009	0.017

Mississippi River Stage: 368.92 ft.-MSL, measured 6/27/89 at 8:15 AM

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drinking water standard. Lead and nickel concentrations have not been shown to be statistically higher than the background well concentrations.

Groundwater Movement - Groundwater flow direction, based on measurements made prior to purging the wells during each sampling event, has been very consistent. Groundwater flows from the hill north of the active portion of the WMA radially outward toward Joachim Creek. This is true during both low and relatively high water table conditions. Typical water table contours for this portion of the WMA are presented in Figure 8. Slug tests have been performed on most of the monitoring wells. Wells 5 and 11 were damaged prior to the time the slug tests were performed, and so no data were obtained for those wells. The slug test data for the remaining wells are presented in Table 13. The hydraulic conductivity of the soils surrounding the wells varies through three orders of magnitude, from approximately 6×10^{-6} cm/sec to 6×10^{-3} cm/sec. As seen in the water table map (Figure 8), the slope of the water table ranges from approximately 0.005 to 0.02. This suggests that contaminants which enter the more permeable strata can migrate at the rate of about 100 feet per year.

Geological Features - There are no mines, shafts, karst areas or caves known to be in the area which could affect waste disposal in the WMA. There is a block fault located approximately one-half mile north of the WMA, but this is not expected to have any impact on waste disposal in the WMA. This fault is discussed in more detail in the subsection titled Geology and Soils.

There are some manmade features which do exist within the WMA which have the potential to impact waste disposal operations. These include a sanitary sewer line and a natural gas pipeline. These are shown on Sheets 1 and 2. The pipeline route is outside the area proposed for disposal of slag, but very close to it. The effect of the pipeline is, therefore, that it limits the area which can be used for slag disposal. No other effect is anticipated.

The sanitary sewer line runs underneath a portion of the slag pile. This sewer line is scheduled for replacement and rerouting in 1990. The new route will not be within the proposed WMA. The old sewer line will be disconnected and abandoned in accordance with state guidelines. This is expected to include either grouting in place or removal and backfilling. It is anticipated that the sewer will be grouted in place where it passes beneath the slag pile.

Future Groundwater Monitoring Program

Monitoring During the Active Life of the Site - The current groundwater monitoring program will be continued during the active life of the site. The only changes to the current program will be to replace monitoring well numbers 8 and 9 when filling that

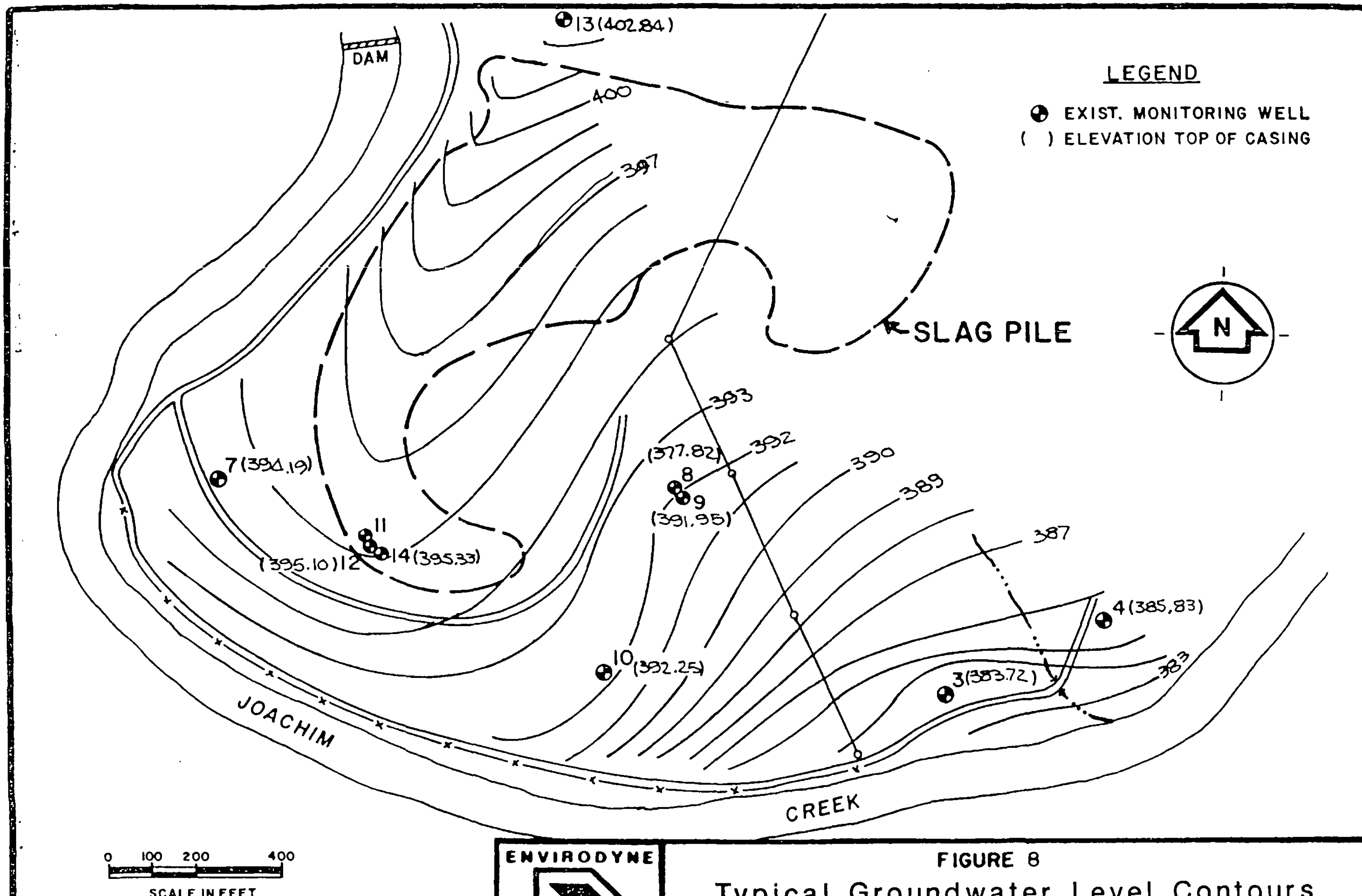

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FIGURE 8
Typical Groundwater Level Contours
12/30/87 and 1/11/88
Active Waste Management Area

TABLE 13

SUMMARY OF SLUG TEST DATA

Well	S	t (sec.)	T (cm^2/sec.)	Ls (cm)	K (cm/sec.)	K m/d
1	10^{-1}	4800	0.0013	151.4	8.6×10^{-6}	7.4×10^{-3}
2	10^{-10}	29	0.22	151.4	1.4×10^{-3}	1.21
3	10^{-2}	25	0.25	227.1	1.1×10^{-3}	0.95
4	10^{-9}	51	0.12	148.4	8.1×10^{-4}	0.7
5	No Test Performed					
6						
1 of 2	10^{-10}	9	0.72	302.8	2.4×10^{-3}	2.07
2 of 2	10^{-10}	9	0.72	302.8	2.4×10^{-3}	2.07
7	10^{-6}	7.8	0.83	302.8	2.7×10^{-3}	2.33
8	10^{-2}	3600	0.0018	302.8	5.9×10^{-6}	5.1×10^{-3}
9	10^{-1}	7.8	0.83	454.2	1.8×10^{-3}	1.55
10	10^{-10}	9.0	0.72	454.2	1.6×10^{-3}	1.38
11	No Test Performed					
12	10^{-2}	1680	0.0038	302.8	1.2×10^{-5}	1.04×10^{-2}
13	10^{-10}	6	1.07	334.59	3.2×10^{-3}	2.76
14	10^{-10}	2.5	2.58	454.2	5.7×10^{-3}	4.92

S = Storage Coefficient Range (from graphs)

t = Time in seconds from type curve, where $\frac{Tt}{Rc^2} = 1$

Rc^2 = Radius of screen-squared = 0.007 ft.^{2}

T = Transmissivity = Rc^2/t

Ls = Saturated screen length

K = Hydraulic Conductivity = T/Ls

portion of the WMA is started. These wells will be replaced with wells having similar depths but located just south of the proposed limits of the slag. Replacement will include abandoning the existing wells in accordance with Missouri Department of Natural Resources (MDNR) guidelines. Well Numbers 5, 11, 12, and 14 will not need to be replaced until final closure of that area commences.

Monitoring During the Post-Closure Period - The current groundwater monitoring program will be continued for a period of not less than 20 years after closure of the site. During closure of the active portion of the WMA well numbers 5, 11, 12, and 14 will be replaced. These four existing wells will be abandoned in accordance with MDNR guidelines, and two new wells will be installed at the southwestern boundary of the slag pile to replace them. One of the new wells will tap the uppermost portion of the alluvium (top of screen elevation approximately 390 feet). The other well will tap a slightly deeper interval, from 25-35 feet below grade (screened interval from approximately elevation 360 to 370 feet).

Section 6.3 (3): Waste Management Structures Control

No dams or other qualifying structures are present or planned within the WMA or immediate vicinity.

Section 6.3 (4): Vegetation

The slag pile soil cover and any disturbed area adjacent to the WMA will be revegetated at closure. The cover surface will be treated with any necessary soil amendments and seeded. An appropriate seed mix containing grasses and/or legumes will be selected to establish a permanent vegetative cover which will effectively minimize erosion and support the WMA's final designated use as wildlife habitant.

Section 6.3 (5): Control of Off-Site Removal

No recycling or reclamation of the waste is deemed feasible at this time. The Doe Run Company reserves the right to propose such recycling or reclamation in the future as a separate permit modification.

Section 6.3 (6): Control of Movement from Wind

The slag has a very small percentage of fines. Less than 1% of the slag typically passes a sieve with 0.01 mm openings. The particles of slag also have a very high specific gravity due to the high metal content. This combination of high specific gravity of the particles and large particle size results in essentially no dust or blowing of the wastes by the wind. The location of the WMA in the bottomland also minimizes wind erosion due to the surrounding topography.

Section 6.4: Periodic Review

This closure plan will be reviewed by the operator no less frequently than once every five years, and requests for revising the plan will be made as deemed necessary.

ITEM 10: INSPECTION-MAINTENANCE PLAN

Following closure of the WMA (either partial or complete) a regular Inspection-Maintenance (I-M) Program, including site security measures, will be initiated. I-M activities will include regular visual inspections, performing maintenance repairs as required during the post-closure I-M period and maintaining security of the WMA.

It is envisioned that the visual inspections will be performed quarterly in conjunction with the groundwater monitoring program. During the first year, or until the vegetation is well established, the inspections may be made more frequently. The inspections will consist of a walk-over of the entire WMA to access the area's condition. The visual inspection will focus on the condition of the soil cover. This will include checking for any signs of erosion, sloughing of slopes, or differential settlement. The inspection will also include the examination of the vegetative layer for indication of thin or bare areas and unwanted deep-rooted vegetation which could damage the integrity of the soil cover. In addition, the visual inspection will include a perimeter survey of the condition of the signs (to inform persons that access is restricted to authorized personnel), cables, and fences erected at closure to ensure they are functioning properly.

Findings of the visual inspection will be presented in a brief written report. Any deficiencies noted during the visual inspection will be documented in the report and accompanied by recommended corrective actions.

The WMA will be maintained by performing corrective actions on an as-needed basis. Any area of significant erosion or sloughing will be repaired and revegetated. If differential settlement occurs, additional cover soil will be added to minimize further detrimental impacts. Area of the cover having thin or damaged vegetation will be reseeded and fertilized as necessary to sustain a dense vegetative layer. Any brush/trees will be removed. Damaged perimeter signs, cables, and fences will be repaired or replaced as necessary to maintain security within the WMA.

The I-M activities are expected to occur for a period of 20 years to ensure the WMA is self-sustaining. However, if the soil/vegetative cover has stabilized prior to this time and no significant repairs have been made in the preceding five years, the visual inspections will cease. Modifications to the I-M Program will be made as necessary throughout the duration of the I-M period but will be reviewed and updated, as a minimum, every five years.

ITEM 11: NPDES PERMIT & DAM SAFETY REGISTRATION

There are no dams at the Herculaneum Smelter Facility or the WMA. There is no point source discharge of any type from the current WMA, and so there is no NPDES Permit for the WMA. The Herculaneum Smelter Facility does have an NPDES Permit, Number MO-0000281 issued March 23, 1987.

ITEM 12: MEASURES TO PROTECT SURFACE WATER AND GROUNDWATER

Description of the Process

Although there have been smelting operations on the site since 1892, the existing primary smelter process train was rebuilt in 1965-67 to treat lead concentrates from the New Lead Belt of Southeast Missouri. It has a nominal production capacity of 240,000 tons per year of lead. The major components of the smelting operations include: sintering to remove sulfur and concurrently agglomerate fine-sized feed materials; blast furnace smelting of sinter with coke and fluxes to make lead bullion; drossing the impure bullion with sulfur and pyrite to remove most of the copper; and treating copper dross to produce a copper matte and crude lead bullion. The lead bullion is further refined extracting silver and other trace metals before alloying and casting. A strip lead product is also made at the site.

Waste Characterization

The slag consists of black, fine-sand sized material, resulting from the granulation of molten lead smelting slag by quenching in a water stream. After granulation, the slag has a typical grain size distribution of:

Opening, mm (approximate)	Percent Retained
4.80	0.5
1.06	6.3
0.23	30.2
0.05	59.8
0.01	3.2

A small percentage of the slag is coarse slag which was cast and broken rather than granulated prior to being placed in the storage area. Because of the low percentage of fines, all of the slag material has a very low natural moisture content (much less than the natural silty/clayey alluvium). The slag pile area has also received a small amount of the slag furnace linings, and kettle settings.

The current slag pile covers an area of approximately 22.5 acres. As of the end of January, 1990, the volume of slag within this area was approximately 1.1 million cubic yards. The in-place density of the slag is approximately 150 pounds per cubic foot. At the current rate of processing ore through the smelter, slag is generated at a rate of approximately 90,000 tons per year (approximately 44,000 cubic yards per year).

A typical assay of the Herculaneum Smelter's slag is:

Pb%	Cu%	SiO_2%	FeO%	CaO%	MgO%	Zn%	S%	Cd%	Al_2O_3%	Ag
2.2	0.25	23.8	33.7	10.8	6.0	9.8	1.8	<0.05	5.0	0.26 oz. per ton

Protection of Groundwater

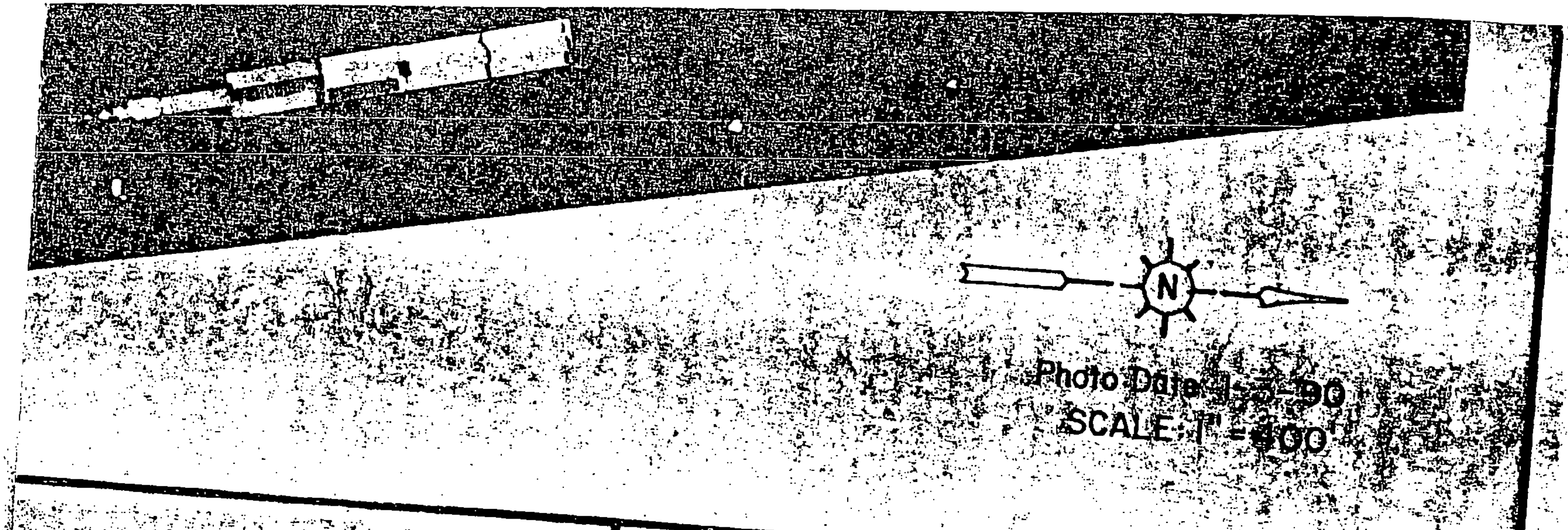
Slag disposal operations have been occurring in the currently active portion of the WMA for 50 years. The process which generates the slag in its present form has been used since about 1967. Groundwater quality has been monitored within the WMA since 1980. Only minor changes have been detected in the quality of the groundwater downgradient from the slag pile. Slightly elevated (but still well below drinking water standards) concentrations of zinc have been detected in one downgradient monitoring well (Well 14), and slightly elevated electrical conductivity measurements have been detected in 5 downgradient monitoring wells (numbers 4, 7, 9, 10, and 14).

The elevated electrical conductivity measurements suggest that the wells are properly positioned to monitor groundwater that has been effected by the slag pile (i.e., close enough to the pile, downgradient from the pile, and screened in the correct depth interval). This, coupled with the general lack of heavy metal contamination in the wells, suggests that the slag pile is currently not having a significant adverse impact on the quality of the groundwater in the WMA. Therefore, it is believed that no changes in the current method of operation of the WMA are needed to protect groundwater quality.

To provide an early warning if the situation changes over time and groundwater does start to become contaminated from the slag pile, the current groundwater monitoring program will be continued. A few minor changes will be required as the area covered by the slag continues to grow. Due to the relatively slow rate of movement of groundwater in the WMA and the lack of groundwater use downgradient from the WMA, continued monitoring will provide adequate warning should the current conditions start to change.

The slag is a highly permeable material (see discussion of waste characteristics in Item 12). Due to the current configuration of the surface of the slag pile and the coarse texture of the slag, essentially all of the incident precipitation percolates into the slag, minus whatever percentage of the precipitation evaporates directly from the surface of the slag. Essentially no direct runoff from the slag pile presently occurs. This, coupled with the naturally high water table in the WMA, has resulted in a slight mounding of the water table within the slag.

At closure of the site, the hydrologic cycle of the slag pile will be substantially changed. The slag will be graded to promote surface runoff while minimizing the potential for erosion. The slag will be covered with compacted soil of low permeability. These changes alone will cause most of the incident precipitation to run off of the surface of the slag pile. Deep percolation of the remaining precipitation will be further minimized by establishing and maintaining a dense vegetative cover, thereby promoting evapotranspiration. These aspects of the closure design are expected to substantially reduce or eliminate the amount of percolation of water through the slag. This will reduce or eliminate the long term potential for contamination of groundwater within and downgradient from the WMA.



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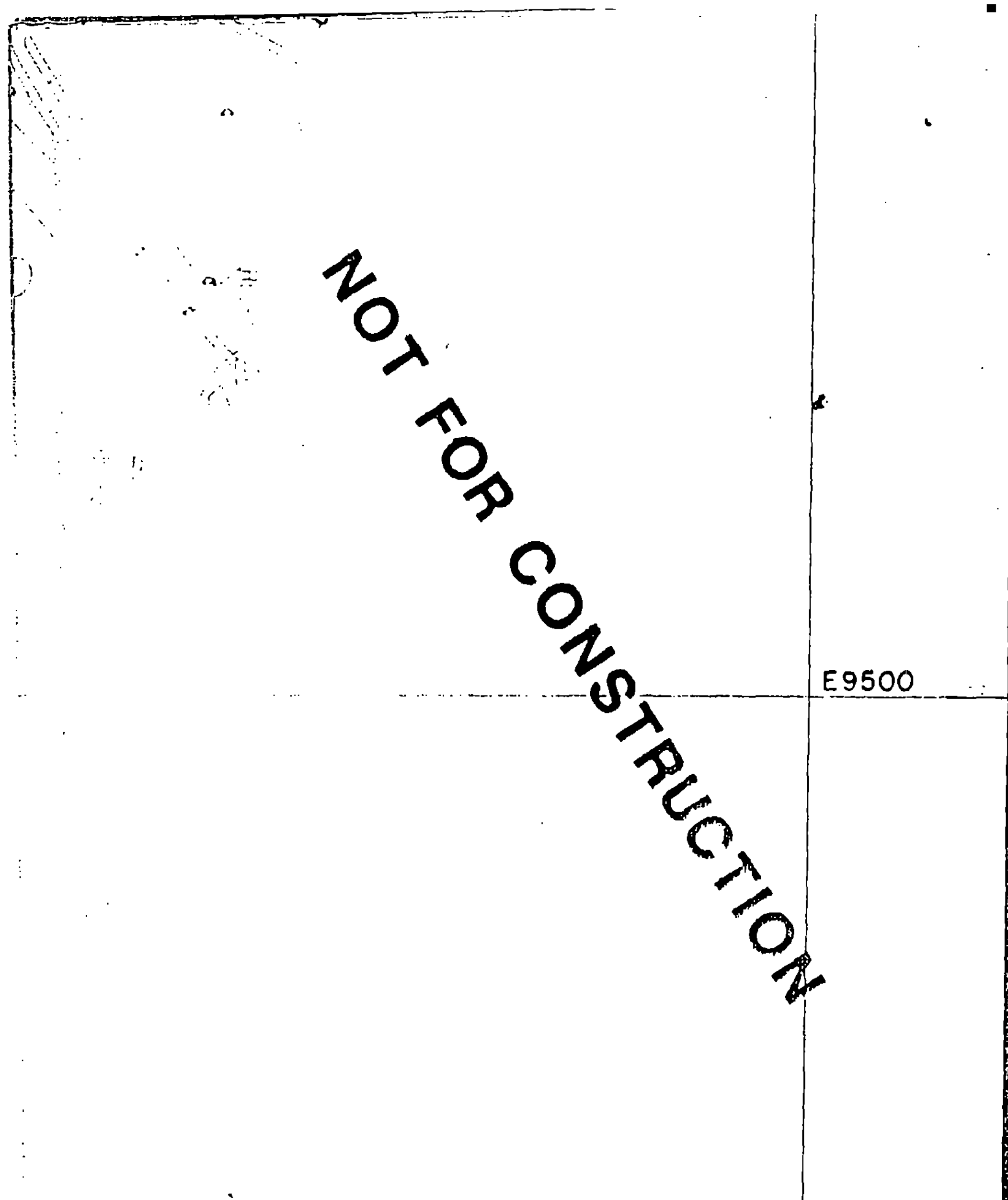
COMPANY

EUM SMELTER FACILITY

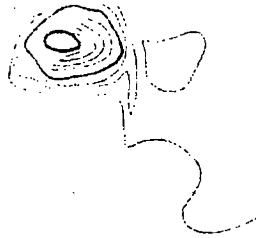
TITLE: Aerial Photograph of Waste Management Area			
DESIGNED BY: JRT/KAB	PROJECT NO. 3502		SHEET 1 of 4
DRAWN BY:			
CHECKED BY:	DATE: 2-23-90		

OVERSIZED



TITLE CONCEPTUAL LAYOUT & UTILITIES MAP ACTIVE WASTE MANAGEMENT AREA		
DESIGNED BY: DJM DRAWN BY: Jm CHECKED BY: RT	PROJECT NO. 3502 DATE: 2-23-90	SHEET 2 of 4

OVERSIZED



NOTES:

1. INTERCEPTOR DITCHES TO BE USED TO DIRECT RUNOFF TO BASE OF SLAG PILE.
2. RUNON TO BE DIVERTED AROUND SLAG PILE.

E9,500

T FOR CONSTRUCTION

TITLE

CONCEPTUAL GRADING/DRAINAGE PLAN
ACTIVE WASTE MANAGEMENT AREA

DESIGNED BY: DM	PROJECT NO. 3502	SHEET 3 of 4
DRAWN BY:		
CHECKED BY: JRT	DATE: 2-23-90	

OVERSIZED

E7,500

NOTES:

1. INTERCEPTOR DITCHES TO BE USED TO DIRECT RUNOFF TO BASE OF SLAG PILE.
2. RUNON TO BE DIVERTED AROUND SLAG PILE.

ONSTRUCTION

TITLE CONCEPTUAL GRADING/DRAINAGE PLAN FUTURE WASTE MANAGEMENT AREA		
DESIGNED BY: DM	PROJECT NO. 3502	SHEET 4 of 4
DRAWN BY:		
CHECKED BY: JET	DATE: 2-23-90	

OVERSIZED

dragged down the hole during drilling and/or well installation procedures. Well 14 was therefore installed using a different technique.

The hole for Well 14 was advanced to the slag/soil interface using hollow stem augers. A permanent steel casing was then placed inside the hollow stem of the augers and grouted into place. The grout inside the casing was then drilled out and the hole advanced to depth using standard rotary drilling techniques. The PVC screen, casing, sandpack and grout were then placed inside the steel casing. It is believed that this technique minimized the potential for slag to fall or be dragged down into the screened interval of the hole. The rest of the monitoring wells are set in the silty/clayey alluvium of Joachim Creek as close to the water table as possible while still achieving a good grout seal above the well screens. Typical top of well screen elevations for these wells range from 375 to 396 feet above sea level. Table 3 summarizes the construction details of these groundwater monitoring wells.

There are numerous groundwater production wells (residential, municipal and industrial) within a 1-mile radius of the WMA. The locations of the wells identified to date are presented in Sheet 1. All of these wells draw their water from the bedrock formations. None of the wells draw water from the silty/clayey Joachim Creek alluvium. Table 4 summarizes the information available for the construction of these wells.

Current Monitoring Program - Not all of the existing groundwater monitoring wells are currently being sampled and analyzed. Wells 1, 2, 5, and 11 are not part of the present monitoring program. It is believed that the remaining wells provide adequate information concerning the quality of the groundwater within the WMA.

These remaining wells (numbers 3, 4, 7, 8, 9, 10, 12, 13, and 14) are sampled and analyzed on a quarterly basis for dissolved lead, nickel, and zinc. Electrical conductivity (E.C.) and pH values were monitored quarterly as indicator parameters. Samples from these wells are also analyzed on an annual basis for all of the metals listed in Table 1 of 40 CFR 264.94. These include arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. Lead, nickel, and zinc were the only metals chosen for quarterly monitoring because they were the only metals which leached out of the slag when the slag was subjected to the EP Toxicity test. The other metals have been monitored only as a precautionary measure, and so have been monitored on a less frequent basis.

A summary of the laboratory data for the past two years is presented in Tables 5 through 12. As can been seen from the data, the slag has had very little impact on the groundwater quality. A statistical analysis of the data included in Tables 5 through 12 has shown that zinc concentrations in well number 14 and electrical conductivity measurements in well numbers 4, 7, 9, 10, and 14 to be significantly higher than background well concentrations (well number 13), though the zinc concentration is still well below the

TABLE 3

SUMMARY OF GROUNDWATER MONITORING WELL CONSTRUCTION WELLS 1 THROUGH 14

Well Number	Total Length of Well BGL	Total Length Well Screen	Top of Well Screen (MSL)
1	30'	5'	388.30'
2	25'	5'	396.86'
3	20'	7.5'	380.05'
4	20'	7.5'	379.83'
5	-	-	-
6	15'	10'	387.62'
7	15'	10'	389.83'
8	94'	10'	305.99'
9	29.9'	15'	374.89'
10	30.3'	15'	377.35'
11	41.5'	10'	390.43'
12	61.6'	10'	369.75'
13	40'	15'	410.30'
14	67'	15'	369.66'

DRM006/1

TABLE 4

SUMMARY OF PRODUCTION WELL CONSTRUCTION WELLS A THROUGH O

Well	Ground Surface Elevation (Feet above MSL)	Uppermost Bedrock Formation	Top and Bottom Elevation of St. Peter Sandstone (Feet above MSL)	St. Peter Sandstone Thickness (ft)
A	445	Joachim	395-325	70
B	442	St. Peter	392-342	50
C	450	St. Peter (?)	325-270	55
D	510	Joachim	415-365	50
E	565	Joachim	465 (top)	-
F	598	Joachim	423-358	65
G	565	Joachim	410 (top)	-
H	610	Joachim (?)	440 (top)	-
I	582	Joachim	462-412	50
J	608	Joachim	438-378	60
K	598	Plattin	423-358	65
L	398	Plattin	253 (top)	-
M	403	?	223 (top)	-
N	480	Plattin	175-110	65
O	552	Plattin	202-162	40

DRM006/1

TABLE 5

ANALYTICAL RESULTS
DOE RUN - HERCULANEUM
COLLECTION DATE: 9-3-87

Well	Depth	Elevation	pH	EC	T	Ag	As	Ba	Cd	Cr	Hg	Ni	Pb	Se	Zn
	Ft below top of casing	ft msl		umho/cm	°C	mg/l	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	ug/l	mg/l
3	9.17	383.38	7.4	1100	15	<.02	<3.1	.092	<.005	<.01	<0.2	<0.02	<.02	<2.1	<0.02
4	7.63	384.70	7.4	1200	15	<.02	<3.1	.130	<.005	<.01	<0.2	<0.02	<.02	<2.1	0.03
7	8.58	388.24	8.0	1200	20	<.02	<3.1	.121	<.005	<.01	<0.2	<0.02	<.02	<2.1	0.04
8	34.08	358.37	7.2	980	15	<.02	<3.1	.173	<.005	<.01	<0.2	<0.02	<.02	<2.1	<0.02
9	3.92	388.97	7.6	1800	17	<.02	<3.1	.142	<.005	<.01	<0.2	<0.02	<.02	<2.1	<0.02
10	8.04	387.11	7.6	1700	17	<.02	<3.1	<.05	<.005	<.01	<0.2	<0.02	<.02	<2.1	<0.02
11	29.42	395.01				Well not routinely sampled									
12	30.92	392.93	8.6	1300	19	<.02	11.09	.184	<.005	<.01	<0.2	<0.02	<.02	<2.1	<0.02
13	35.67	402.13	7.5	1000	15	<.02	<3.1	.087	<.005	<.01	<0.2	<0.02	<.02	<2.1	<0.02
14	30.92	393.24	7.8	1800	19	<.02	<3.1	.104	<.005	<.01	<0.2	<0.02	<.02	<2.1	0.06

· River Stage at Dock: 381.08 ft msl at 9:30 AM September 3, 1987

TABLE 6
ANALYTICAL RESULTS
DOE RUN - HERCULANEUM
COLLECTION DATES 12/30/87 (1) and 1/11/88 (2)

	Depth to Water	Elevation of Water Table	pH	Electrical Conductivity	Temperature	Nickel	Lead	Zinc
Well No.	Ft. Below Top of Casing	Ft.-MSL		umhos/cm	°C	mg/l	mg/l	mg/l
3 (2)	8.38	383.72	6.4	620	12	0.003	<0.005	0.016
4 (2)	6.50	385.83	6.7	890	12	0.003	<0.005	0.027
7 (1)	2.23	394.59	7.0	1010	13	0.003	<0.005	0.027
8 (1)	14.63	377.82	7.0	690	12	<0.002	<0.005	0.013
9 (1)	0.94	391.95	6.5	1420	12	<0.002	<0.005	0.016
10 (1)	2.90	392.25	6.8	1290	13	0.003	<0.005	0.008
12 (1)	28.75	395.10	7.4	920	14	<0.002	<0.005	<0.002
13 (1)	34.96	402.84	6.9	750	13	0.003	<0.005	0.011
14 (1)	28.83	395.33	6.8	2050	16	<0.002	<0.005	0.056

Mississippi River Stage: 388.88 ft.-MSL, measured 12/30/87 at 12:45 PM.

TABLE 7
ANALYTICAL RESULTS
DOE RUN - HERCULANEUM
COLLECTION DATES 3/30/88 (1)

	Depth to Water	Elevation of Water Table	pH	Electrical Conductivity	Temperature	Nickel	Lead	Zinc
Well No.	Ft. Below Top of Casing	Ft.-MSL		umhos/cm	°C	mg/l	mg/l	mg/l
3	4.58	387.97	6.7	824	11.6	0.024	0.012	0.024
4	6.85	385.48	7.0	1264	12.0	0.009	0.017	0.066
7	1.50	395.32	7.0	963	11.3	0.014	0.020	0.093
8	22.81	369.64	7.6	785	13.9	0.011	0.015	0.019
9	11.02	381.87	6.3	1743	14.1	0.008	0.016	0.014
10	3.43	391.72	6.9	1621	12.8	0.009	0.010	0.006
12	28.85	395.02	7.1	1164	16.9	0.008	0.014	0.006
13	33.83	403.97	6.8	1036	12.9	0.009	0.009	0.012
14	29.00	395.16	6.5	2600	17.8	0.018	0.015	0.054

Mississippi River Stage: 381.1 ft.-MSL, measured 3/30/88 at 9:45 AM.

TABLE 8

ANALYTICAL RESULTS
DOE RUN - HERCULANEUM
COLLECTION DATES 6/29/88

	Depth to Water	Elevation of Water Table	pH	Electrical Conductivity	Temperature	Nickel	Lead	Zinc
Well No.	Ft. Below Top of Casing	Ft.-MSL		umhos/cm	°C	mg/l	mg/l	mg/l
3	12.7	379.85	6.55	1005	12.6	0.006	0.006	0.033
4	9.0	383.33	6.90	1597	13.1	0.008	<0.006	0.037
7	9.75	387.07	6.90	1580	13.5	0.005	0.010	0.034
8	29.5	362.95	7.15	795	14.7	0.006	<0.006	0.020
9	4.5	388.39	6.50	1770	15.2	<0.004	0.015	0.016
10	9.0	386.15	6.80	625	13.0	0.005	<0.006	0.013
12	31.9	391.95	7.05	1257	18.0	<0.004	<0.006	0.013
13	33.9	403.90	6.80	1050	16.1	<0.004	<0.006	0.019
14	32.3	391.86	6.55	2780	18.9	<0.004	0.011	0.088

Mississippi River Stage: 364.1 ft.-MSL, measured 6/29/88 at 8:30 AM.

TABLE 9

ANALYTICAL RESULTS

DOE RUN - HERCULANEUM

COLLECTION DATE: September 29, 1988

Well	Depth	Elevation	pH	EC	T	Ag	As	Ba	Cd	Cr	Hg	Ni	Pb	Se	Zn
	Ft. Below top of casing	Ft. msl		umho/ cm	*C	mg/l	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	ug/l	mg/l
3	15.0	377.55	6.5	817	14.2	<0.003	<3.1	0.131	0.002	<0.004	<0.2	0.013	<0.005	<2.1	0.030
4	10.5	381.83	6.7	2160	14.7	<0.003	<3.1	0.184	0.003	<0.004	<0.2	0.016	<0.003	3.3	0.045
7	9.8	387.02	6.9	1774	16.0	<0.003	<3.1	0.105	0.002	<0.004	<0.2	0.013	<0.003	2.5	0.043
8	31.3	361.15	7.3	686	16.2	<0.003	<3.1	0.107	<0.002	<0.004	<0.2	0.008	<0.003	<2.1	0.015
9	4.7	388.18	6.6	1668	15.5	<0.003	6.0	0.131	0.002	<0.004	<0.2	0.010	<0.003	<2.1	0.041
10	9.5	385.65	6.7	1649	14.3	<0.003	<3.1	0.038	<0.002	<0.004	<0.2	0.008	<0.003	<2.1	0.019
12	31.8	392.05	7.0	1153	18.9	<0.003	21.0	0.176	0.002	<0.004	<0.2	0.009	<0.003	<2.1	0.017
13	36.0	401.80	6.9	929	14.6	<0.003	<3.1	0.089	0.002	0.005	<0.2	0.010	<0.003	<2.1	0.024
14	31.9	392.26	6.6	2670	19.9	<0.003	<3.1	0.052	0.003	<0.004	<0.2	0.011	<0.003	<2.1	0.049

River Stage at Dock: 367.04 ft. msl at 8:15 AM September 29, 1988.

TABLE 10

ANALYTICAL RESULTS

DOE RUN - HERCULANEUM

COLLECTION DATE - DECEMBER 29, 1988

Well No.	Depth to Water Ft. Below Top of Casing	Elevation of Water Table Ft.-MSL	pH	Electrical Conductivity umhos/cm	Temperature °C	Nickel mg/l	Lead mg/l	Zinc mg/l
3	9.67	382.88	6.7	841	13.1	0.008	<0.006	0.039
4	8.65	383.33	6.4	2620	12.5	0.017	0.010	0.065
7	3.00	393.82	6.8	1345	12.2	0.008	<0.006	0.068
8	27.83	364.62	7.1	638	11.7	0.008	0.008	0.035
9	1.08	391.81	6.5	1773	11.0	0.007	<0.006	0.048
10	3.92	391.23	6.6	1650	12.0	0.010	0.007	0.035
12	29.04	394.81	7.2	1228	15.4	0.005	0.007	0.034
13	35.33	402.47	6.7	975	10.9	0.008	<0.006	0.045
14	29.08	395.08	6.3	2780	14.3	0.009	0.010	0.048

Mississippi River Stage: 379.08 ft.-MSL, measured 8:00 a.m. on December 29, 1988

/002M

TABLE 11
ANALYTICAL RESULTS
DOE RUN - HERCULANEUM
COLLECTION DATE - March 27, 1989

Well No.	Depth to Water Ft. Below Top of Casing	Elevation of Water Table Ft.-MSL	pH	Electrical Conductivity umhos/cm	Temperature °C	Nickel mg/l	Lead mg/l	Zinc mg/l
3	7.88	384.67	6.4	829	12.9	<0.015	<0.003	0.021
4	6.25	386.08	6.6	2470	12.6	0.018	0.010	0.053
7	2.75	394.07	6.8	1464	12.4	<0.015	0.006	0.024
8	27.29	365.16	7.3	845	15.5	<0.015	<0.003	0.016
9	1.00	391.89	6.7	1750	14.9	<0.015	0.006	0.017
10	4.23	390.92	6.9	1616	12.9	<0.015	0.009	0.045
12	29.06	394.79	7.0	1236	17.9	<0.015	0.004	0.037
13	34.81	402.99	6.9	997	14.1	<0.015	0.004	0.032
14	29.25	394.91	6.9	2670	18.0	0.016	0.017	0.099

Mississippi River Stage: 372.34 ft.-MSL, measured March 27, 1989 at 9 AM.

/002M

TABLE 12

ANALYTICAL RESULTS
DOE RUN - HERCULANEUM
COLLECTION DATES 6/27/89

	Depth to Water	Elevation of Water Table	pH	Electrical Conductivity	Temperature	Nickel	Lead	Zinc
Well No.	Ft. Below Top of Casing	Ft.-MSL		umhos/cm	°C	mg/l	mg/l	mg/l
3	9.83	382.72	6.70	705	12.9	<0.015	0.005	<0.016
4	6.96	385.37	6.85	2030	12.7	0.016	0.010	0.032
7	7.33	389.49	7.00	1350	14.0	<0.015	0.006	<0.016
8	28.81	363.64	7.30	620	16.0	<0.015	0.006	<0.016
9	1.46	391.43	6.75	1475	15.0	<0.015	0.005	<0.016
10	6.49	388.66	6.95	1250	12.1	<0.015	0.005	<0.016
12	30.71	393.14	7.30	1150	18.9	<0.015	0.003	0.017
13	34.83	402.97	7.00	900	14.9	<0.015	<0.001	<0.016
14	30.83	393.33	6.60	2390	18.0	<0.015	0.009	0.017

Mississippi River Stage: 368.92 ft.-MSL, measured 6/27/89 at 8:15 AM

/355

drinking water standard. Lead and nickel concentrations have not been shown to be statistically higher than the background well concentrations.

Groundwater Movement - Groundwater flow direction, based on measurements made prior to purging the wells during each sampling event, has been very consistent. Groundwater flows from the hill north of the active portion of the WMA radially outward toward Joachim Creek. This is true during both low and relatively high water table conditions. Typical water table contours for this portion of the WMA are presented in Figure 8. Slug tests have been performed on most of the monitoring wells. Wells 5 and 11 were damaged prior to the time the slug tests were performed, and so no data were obtained for those wells. The slug test data for the remaining wells are presented in Table 13. The hydraulic conductivity of the soils surrounding the wells varies through three orders of magnitude, from approximately 6×10^{-6} cm/sec to 6×10^{-3} cm/sec. As seen in the water table map (Figure 8), the slope of the water table ranges from approximately 0.005 to 0.02. This suggests that contaminants which enter the more permeable strata can migrate at the rate of about 100 feet per year.

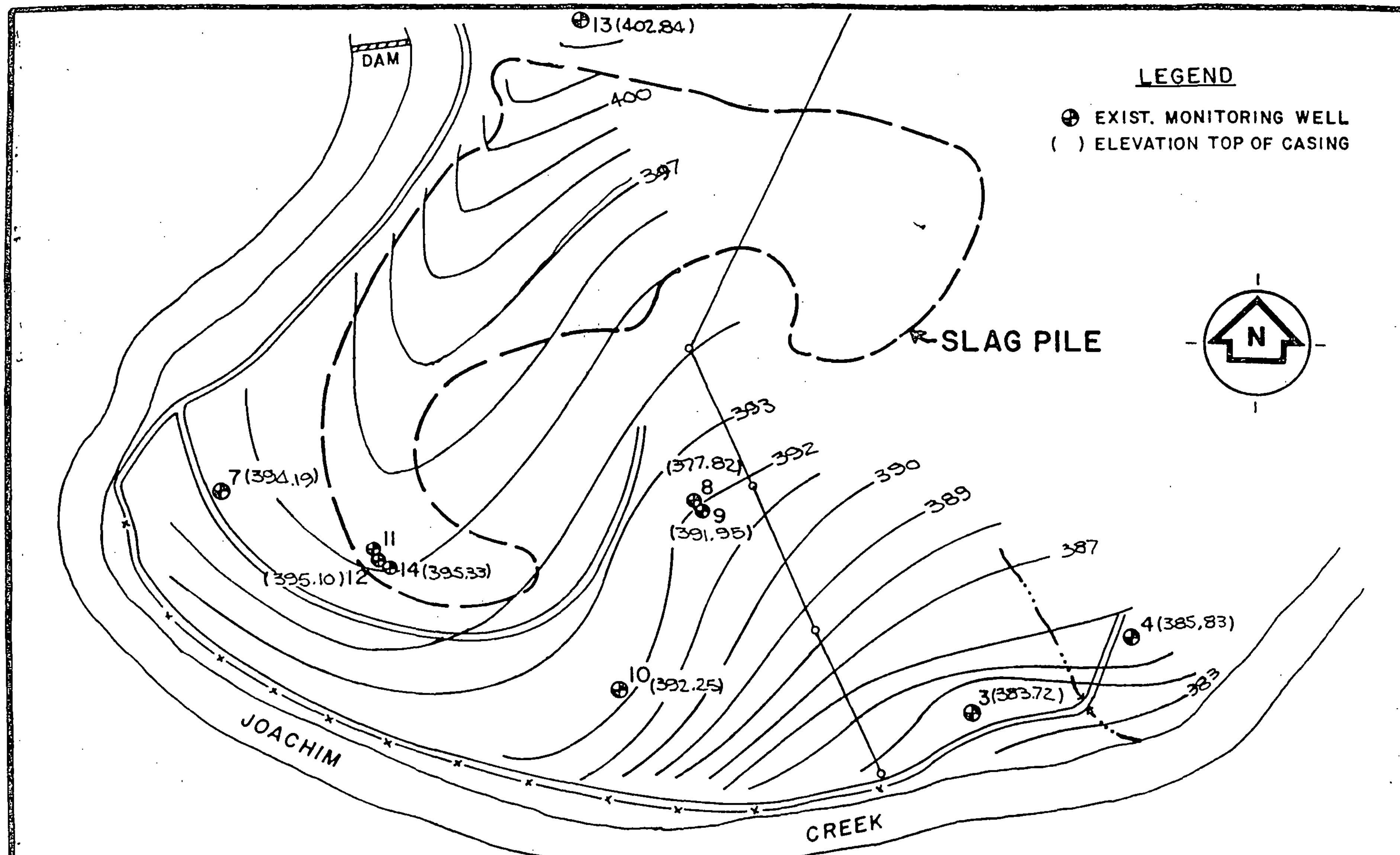
Geological Features - There are no mines, shafts, karst areas or caves known to be in the area which could affect waste disposal in the WMA. There is a block fault located approximately one-half mile north of the WMA, but this is not expected to have any impact on waste disposal in the WMA. This fault is discussed in more detail in the subsection titled Geology and Soils.

There are some manmade features which do exist within the WMA which have the potential to impact waste disposal operations. These include a sanitary sewer line and a natural gas pipeline. These are shown on Sheets 1 and 2. The pipeline route is outside the area proposed for disposal of slag, but very close to it. The effect of the pipeline is, therefore, that it limits the area which can be used for slag disposal. No other effect is anticipated.

The sanitary sewer line runs underneath a portion of the slag pile. This sewer line is scheduled for replacement and rerouting in 1990. The new route will not be within the proposed WMA. The old sewer line will be disconnected and abandoned in accordance with state guidelines. This is expected to include either grouting in place or removal and backfilling. It is anticipated that the sewer will be grouted in place where it passes beneath the slag pile.

Future Groundwater Monitoring Program

Monitoring During the Active Life of the Site - The current groundwater monitoring program will be continued during the active life of the site. The only changes to the current program will be to replace monitoring well numbers 8 and 9 when filling that



0 100 200 400
SCALE IN FEET

ENVIRODYNE ENGINEERS

FIGURE 8
Typical Groundwater Level Contours
12/30/87 and 1/11/88
Active Waste Management Area

TABLE 13
SUMMARY OF SLUG TEST DATA

Well	S	t (sec.)	T (cm^2/sec.)	Ls (cm)	K (cm/sec.)	K m/d
1	10^{-1}	4800	0.0013	151.4	8.6×10^{-6}	7.4×10^{-3}
2	10^{-10}	29	0.22	151.4	1.4×10^{-3}	1.21
3	10^{-2}	25	0.25	227.1	1.1×10^{-3}	0.95
4	10^{-9}	51	0.12	148.4	8.1×10^{-4}	0.7
5	No Test Performed					
6						
1 of 2	10^{-10}	9	0.72	302.8	2.4×10^{-3}	2.07
2 of 2	10^{-10}	9	0.72	302.8	2.4×10^{-3}	2.07
7	10^{-6}	7.8	0.83	302.8	2.7×10^{-3}	2.33
8	10^{-2}	3600	0.0018	302.8	5.9×10^{-6}	5.1×10^{-3}
9	10^{-1}	7.8	0.83	454.2	1.8×10^{-3}	1.55
10	10^{-10}	9.0	0.72	454.2	1.6×10^{-3}	1.38
11	No Test Performed					
12	10^{-2}	1680	0.0038	302.8	1.2×10^{-5}	1.04×10^{-2}
13	10^{-10}	6	1.07	334.59	3.2×10^{-3}	2.76
14	10^{-10}	2.5	2.58	454.2	5.7×10^{-3}	4.92

S = Storage Coefficient Range (from graphs)
t = Time in seconds from type curve, where $\frac{Tt}{Rc^2} = 1$

Rc^2 = Radius of screen-squared = 0.007 $ft.^2$
T = Transmissivity = Rc^2/t
Ls = Saturated screen length
K = Hydraulic Conductivity = T/Ls

portion of the WMA is started. These wells will be replaced with wells having similar depths but located just south of the proposed limits of the slag. Replacement will include abandoning the existing wells in accordance with Missouri Department of Natural Resources (MDNR) guidelines. Well Numbers 5, 11, 12, and 14 will not need to be replaced until final closure of that area commences.

Monitoring During the Post-Closure Period - The current groundwater monitoring program will be continued for a period of not less than 20 years after closure of the site. During closure of the active portion of the WMA well numbers 5, 11, 12, and 14 will be replaced. These four existing wells will be abandoned in accordance with MDNR guidelines, and two new wells will be installed at the southwestern boundary of the slag pile to replace them. One of the new wells will tap the uppermost portion of the alluvium (top of screen elevation approximately 390 feet). The other well will tap a slightly deeper interval, from 25-35 feet below grade (screened interval from approximately elevation 360 to 370 feet).

Section 6.3 (3): Waste Management Structures Control

No dams or other qualifying structures are present or planned within the WMA or immediate vicinity.

Section 6.3 (4): Vegetation

The slag pile soil cover and any disturbed area adjacent to the WMA will be revegetated at closure. The cover surface will be treated with any necessary soil amendments and seeded. An appropriate seed mix containing grasses and/or legumes will be selected to establish a permanent vegetative cover which will effectively minimize erosion and support the WMA's final designated use as wildlife habitant.

Section 6.3 (5): Control of Off-Site Removal

No recycling or reclamation of the waste is deemed feasible at this time. The Doe Run Company reserves the right to propose such recycling or reclamation in the future as a separate permit modification.

Section 6.3 (6): Control of Movement from Wind

The slag has a very small percentage of fines. Less than 1% of the slag typically passes a sieve with 0.01 mm openings. The particles of slag also have a very high specific gravity due to the high metal content. This combination of high specific gravity of the particles and large particle size results in essentially no dust or blowing of the wastes by the wind. The location of the WMA in the bottomland also minimizes wind erosion due to the surrounding topography.

Section 6.4: Periodic Review

This closure plan will be reviewed by the operator no less frequently than once every five years, and requests for revising the plan will be made as deemed necessary.

ITEM 10: INSPECTION-MAINTENANCE PLAN

Following closure of the WMA (either partial or complete) a regular Inspection-Maintenance (I-M) Program, including site security measures, will be initiated. I-M activities will include regular visual inspections, performing maintenance repairs as required during the post-closure I-M period and maintaining security of the WMA.

It is envisioned that the visual inspections will be performed quarterly in conjunction with the groundwater monitoring program. During the first year, or until the vegetation is well established, the inspections may be made more frequently. The inspections will consist of a walk-over of the entire WMA to access the area's condition. The visual inspection will focus on the condition of the soil cover. This will include checking for any signs of erosion, sloughing of slopes, or differential settlement. The inspection will also include the examination of the vegetative layer for indication of thin or bare areas and unwanted deep-rooted vegetation which could damage the integrity of the soil cover. In addition, the visual inspection will include a perimeter survey of the condition of the signs (to inform persons that access is restricted to authorized personnel), cables, and fences erected at closure to ensure they are functioning properly.

Findings of the visual inspection will be presented in a brief written report. Any deficiencies noted during the visual inspection will be documented in the report and accompanied by recommended corrective actions.

The WMA will be maintained by performing corrective actions on an as-needed basis. Any area of significant erosion or sloughing will be repaired and revegetated. If differential settlement occurs, additional cover soil will be added to minimize further detrimental impacts. Area of the cover having thin or damaged vegetation will be reseeded and fertilized as necessary to sustain a dense vegetative layer. Any brush/trees will be removed. Damaged perimeter signs, cables, and fences will be repaired or replaced as necessary to maintain security within the WMA.

The I-M activities are expected to occur for a period of 20 years to ensure the WMA is self-sustaining. However, if the soil/vegetative cover has stabilized prior to this time and no significant repairs have been made in the preceding five years, the visual inspections will cease. Modifications to the I-M Program will be made as necessary throughout the duration of the I-M period but will be reviewed and updated, as a minimum, every five years.

ITEM 11: NPDES PERMIT & DAM SAFETY REGISTRATION

There are no dams at the Herculaneum Smelter Facility or the WMA. There is no point source discharge of any type from the current WMA, and so there is no NPDES Permit for the WMA. The Herculaneum Smelter Facility does have an NPDES Permit, Number MO-0000281 issued March 23, 1987.

ITEM 12: MEASURES TO PROTECT SURFACE WATER AND GROUNDWATER

Description of the Process

Although there have been smelting operations on the site since 1892, the existing primary smelter process train was rebuilt in 1965-67 to treat lead concentrates from the New Lead Belt of Southeast Missouri. It has a nominal production capacity of 240,000 tons per year of lead. The major components of the smelting operations include: sintering to remove sulfur and concurrently agglomerate fine-sized feed materials; blast furnace smelting of sinter with coke and fluxes to make lead bullion; drossing the impure bullion with sulfur and pyrite to remove most of the copper; and treating copper dross to produce a copper matte and crude lead bullion. The lead bullion is further refined extracting silver and other trace metals before alloying and casting. A strip lead product is also made at the site.

Waste Characterization

The slag consists of black, fine-sand sized material, resulting from the granulation of molten lead smelting slag by quenching in a water stream. After granulation, the slag has a typical grain size distribution of:

Opening, mm (approximate)	Percent Retained
4.80	0.5
1.06	6.3
0.23	30.2
0.05	59.8
0.01	3.2

A small percentage of the slag is coarse slag which was cast and broken rather than granulated prior to being placed in the storage area. Because of the low percentage of fines, all of the slag material has a very low natural moisture content (much less than the natural silty/clayey alluvium). The slag pile area has also received a small amount of the slag furnace linings, and kettle settings.

The current slag pile covers an area of approximately 22.5 acres. As of the end of January, 1990, the volume of slag within this area was approximately 1.1 million cubic yards. The in-place density of the slag is approximately 150 pounds per cubic foot. At the current rate of processing ore through the smelter, slag is generated at a rate of approximately 90,000 tons per year (approximately 44,000 cubic yards per year).

A typical assay of the Herculaneum Smelter's slag is:

Pb%	*Cu%*	*SiO%*	*FeO%*	*CaO%*	*MgO%*	*Zn%*	*S%*	*Cd%*	*Al_2O_3%*	*Ag*
2.2	*0.25*	*23.8*	*33.7*	*10.8*	*6.0*	*9.8*	*1.8*	*<0.05*	*5.0*	*0.26 oz. per ton*

Protection of Groundwater

Slag disposal operations have been occurring in the currently active portion of the WMA for 50 years. The process which generates the slag in its present form has been used since about 1967. Groundwater quality has been monitored within the WMA since 1980. Only minor changes have been detected in the quality of the groundwater downgradient from the slag pile. Slightly elevated (but still well below drinking water standards) concentrations of zinc have been detected in one downgradient monitoring well (Well 14), and slightly elevated electrical conductivity measurements have been detected in 5 downgradient monitoring wells (numbers 4, 7, 9, 10, and 14).

The elevated electrical conductivity measurements suggest that the wells are properly positioned to monitor groundwater that has been effected by the slag pile (i.e., close enough to the pile, downgradient from the pile, and screened in the correct depth interval). This, coupled with the general lack of heavy metal contamination in the wells, suggests that the slag pile is currently not having a significant adverse impact on the quality of the groundwater in the WMA. Therefore, it is believed that no changes in the current method of operation of the WMA are needed to protect groundwater quality.

To provide an early warning if the situation changes over time and groundwater does start to become contaminated from the slag pile, the current groundwater monitoring program will be continued. A few minor changes will be required as the area covered by the slag continues to grow. Due to the relatively slow rate of movement of groundwater in the WMA and the lack of groundwater use downgradient from the WMA, continued monitoring will provide adequate warning should the current conditions start to change.

The slag is a highly permeable material (see discussion of waste characteristics in Item 12). Due to the current configuration of the surface of the slag pile and the coarse texture of the slag, essentially all of the incident precipitation percolates into the slag, minus whatever percentage of the precipitation evaporates directly from the surface of the slag. Essentially no direct runoff from the slag pile presently occurs. This, coupled with the naturally high water table in the WMA, has resulted in a slight mounding of the water table within the slag.

At closure of the site, the hydrologic cycle of the slag pile will be substantially changed. The slag will be graded to promote surface runoff while minimizing the potential for erosion. The slag will be covered with compacted soil of low permeability. These changes alone will cause most of the incident precipitation to run off of the surface of the slag pile. Deep percolation of the remaining precipitation will be further minimized by establishing and maintaining a dense vegetative cover, thereby promoting evapotranspiration. These aspects of the closure design are expected to substantially reduce or eliminate the amount of percolation of water through the slag. This will reduce or eliminate the long term potential for contamination of groundwater within and downgradient from the WMA.